TRAFFIC QUARTERLY

AN INDEPENDENT JOURNAL FOR BETTER TRAFFIC

OCTOBER 1956

Ten Years
Boston Central Artery
New Orleans' Highway Program
Traffic Planning in Rhode Island
Stretching the Transportation Dollar
200-Year-Old Manhattan Traffic Problem
Co-ordinating Fields of Engineering
Court Broadens Traffic Powers
Controlling Highway Access
Freeways and the Suburbs
Financing Highways

THE ENO FOUNDATION FOR HIGHWAY TRAFFIC CONTROL

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Ten Years

THIS issue completes the tenth year of the TRAFFIC QUARTERLY. It appears appropriate to comment on the fulfillment of its purpose and make further acknowledgment to authors of a decade of articles.

While the Eno Foundation had long been concerned with the subject of traffic, it realized that the growth of the problem had suddenly become nationally important. The problem concerned everyone—and for some, it had serious connotations.

With the initial issue of the TRAFFIC QUARTERLY, there was reason to believe that there existed many excellent minds in the field of highway traffic, devoting their best thought to the problem. We believed they would share their thinking through an appropriate medium to benefit all concerned in the improvement of traffic conditions, and in possible solutions.

Our authors, authoritative specialists, have been generous. The list of contributors is impressive, and any quality or usefulness the publication may deserve, is due largely to their interest and diligence.

In a continuing analysis of the problems in these ten years much was learned of the complexities of the subject. This led the Foundation to diversify the QUARTERLY's subject matter to meet varied interests.

There has been a lack of uniformity in methods of correcting many traffic problems. To correct this, the Foundation provided scientific discussions and presented basic traffic engineering principles.

We have been aware of the confusion from multiple types of aids, signs, and other devices, violating fundamental principles of traffic engineering. This widespread activity runs contrary to efforts to improve driver knowledge and driving.

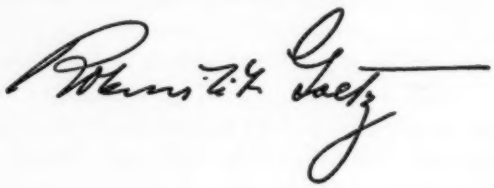
The Foundation consistently stressed the importance of basic co-ordination in the functions of licensing agencies, enforcement, and the judiciary. That co-ordination to improve our driving seems as necessary and appropriate as other national efforts toward assuring health, education, and social welfare.

The character and extent of our daily correspondence demon-

strate the national interest in the traffic problem and the pressing need to meet it.

Foreign mail clearly indicates that the problem is becoming world-wide and that many nations are eager to profit by our knowledge.

The last ten years have been an encouragement, an interesting experience, to the Foundation, and I trust gratifying to our authors. We look forward with pleasure to continuing our best efforts to make authentic literature available in this important field.



Financing Highways Now and in the Future

RICHARD M. ZETTEL

Since 1951, Mr. Zettel has been Research Economist, Institute of Transportation and Traffic Engineering, University of California, Berkeley. He is a member of the State-Wide Highway Committee of the California State Chamber of Commerce. Last year he was on leave to the President's Commission on Intergovernmental Relations, in charge of public finance studies and as adviser to the Commission's Highway Study Committee. In the latter part of 1955 he was economic consultant to the Michigan Legislative Highway Study Committee and completed a report, "Financing Modern Highways for Michigan." Mr. Zettel was executive secretary and director of research of the California Legislature's Joint Committee on Highways, 1952-1953. He has been adviser to various California legislative interim committees on transportation problems since 1946. Immediately before the war, he was employed on the staff of the Board of Investigation and Research and worked on the highway section of the report on Carrier Taxation. He was a member of the National Tax Association's Committee on Taxation of Transportation.

HIGHWAY financing for the immediate or long-run future cannot be discussed meaningfully without considering the nature and causes of present inadequacies and speculating on future demands for highway service. Moreover, an understanding of the origin of the current need for highway improvement, along with its economic justification, suggests the ways and means of financing highways equitably and economically.

One indication of the magnitude of the current highway problem in the United States is found in the inventory completed by the Bureau of Public Roads last year. It reported that expenditures of $100 billion in ten years would be required to improve all roads and streets of the nation to a level which highway engineers would regard as adequate and which presumably would give us the safe, convenient, and economical transportation of which our *present* motor vehicles are capable.

That this figure establishes an acceptable general target is verified by the more carefully completed "deficiency" studies made in a number of states. But it is appropriate to note that even the $100 billion would have provided highways adequate to handle traffic on the 40,000 mile interstate system only to 1974 (eighteen years hence) and on other highways only to 1964 (eight years hence). Construction requirements for thirty years (1954 to 1984) were estimated to be in the magnitude of $215 billion.

Against the $100 billion inventory of ten-year needs, it was estimated that about $47 billion would be available under current methods of financing. Thus, if all the work were to be done in the ten-year period, accelerated construction financing of about $5 billion a year would have to be found. Actually, none of the financing plans considered since the statement of needs appeared has contemplated the full expenditure of $100 billion in ten years (including the recently enacted federal program which adds about $2 billion a year for thirteen years to "normal" financing).

The immediate highway problem is sometimes characterized as need for a crash program to catch up on a great backlog of accumulated critical deficiencies. This is only partly true. A backlog does exist as a result of missed opportunities during the depression, the consequences of World War II, and failure to adjust rates of highway financing to the realities of post-war inflation. But the highway financing problem involves more than catching up.

The entirely new concepts of design and higher standards of construction which our engineers now regard as necessary to provide optimum traffic mobility are perhaps more important than anything else in swelling current estimates of highway needs. Much of our existing plant has become functionally obsolete in terms of modern engineering know-how.

The Future Demand for Highways

Vast development of freeways and expressways, and of by-passes and through-passes, is necessary merely to provide adequate service to existing traffic. But the greater problem will be one of meeting the future demand for more road space. That demand will result from our growing population, from our greater productivity, our

rising incomes, our greater leisure, and our continuing changes in our patterns of living.

The obvious factor giving rise to demand for more highway space in the future is our growing population, the economic consequences of which are still but vaguely perceived by most of our people and many of our planners. A population of 225 million in 1975, an increase of 36 percent over 1955—these forecasts are not at all unreasonable.

But it is unrealistic to assume that highway travel will increase only 36 percent in twenty years. The President's Advisory Committee on a National Highway Program forecast that in only ten years traffic will be about 43 percent above the 1955 level—81 million motor vehicles traveling 814 billion miles.

In my judgment, it is not unreasonable to anticipate 100 million motor vehicles traveling 1,000 billion vehicle miles in 1975. Figures below these magnitudes will be more surprising than figures above.

One point to note in speculating on future demand for highway transportation is that the 1960's will see a high rate of family formation as the war and early pre-war baby crop reaches maturity. These new families will be entering the labor market and acquiring homes and motor vehicles for the first time. This alone should cause a substantial upsurge in demand for highway travel. It is also to be expected that the relative number of women drivers and the amount of driving they do will increase at a faster rate than population increases.

The Growing Economy. The most important factor in anticipating highway demand—and one often neglected—is the prospective growth of our total economy. In fact, these possible strides in productivity lie at the base of my speculation of 100 million vehicles and a trillion miles for 1975. An annual rate of increase of three percent a year, which is quite feasible in the eyes of a number of economists, would mean a gross national product on the order of $700 billion in 1975, some 80 percent higher than the 1955 figure.[1]

The impact of such economic growth on transportation in gen-

[1] The central theme of the program of the meeting of the American Economic Association held in December, 1955 was the economic growth of the United States. The papers of ten sessions relating to economic growth are published in the "Papers and Proceedings of the 68th Annual Meeting of the American Economic Association," May, 1956.

eral and highway transportation in particular must be apparent. Naturally the greater production and flow of goods and services will require something like a proportional increase in commercial transportation. Recent trends suggest that commercial highway transportation will capture more than its proportional share.

The effective demand for personal transportation is bound to be affected by the greater productivity which will be reflected in higher incomes which in turn must be spent for goods and services if the economy is to be sustained. There is reason to believe that personal transportation will share somewhat more than proportionately in the increased expenditures for goods and services.

This conclusion is fortified by the clear prospect that part of the potential in increased productivity will be diverted to greater leisure. In estimating a product of $535 billion in 1965, the staff of the Joint Committee on the Economic Report assumed a reduction of work of 200 hours per man per year (the equivalent of 20 to 25 days additional vacation or four hours reduction in the average work-week) through some combination of additional vacation and reduced work-week.[2] Further reduction by 1975 is to be expected. While it is true that gross product will be greater if hours are not reduced as much as anticipated and will be less if they are reduced more, insofar as travel is concerned, a compensating result is to be noted. Somewhat higher income and a little less leisure or somewhat lower income and a little more leisure may have about the same effect on the demand for personal travel.

We can be reasonably confident that highway transportation will more than hold its share of personal transportation in rural, suburban, and intercity travel, at least for the short- and medium-distance movements which make up the vast bulk of all highway travel. It is more hazardous to speculate on highway transportation's share of total personal transportation in metropolitan areas.

The Urban Problem. A considerable body of respectable opinion believes that urban transportation problems cannot be solved by highway improvements. Some in this school hold that freeway development merely compounds problems by pouring more vehicles onto already congested streets and into inadequate terminal areas. The

[2] *Potential Economic Growth of the United States during the next decade,* 1954.

extremists would go so far as virtually to ban automobile traffic or to make it so costly as to curtail drastically its use in larger central cities.

At the other extreme are those who visualize an almost complete rebuilding of our urban economies around an improved system of highway transportation, including (not too hopefully) improved mass transit in buses.

A middle course seems the more likely. Admittedly the costs of highway improvement in urban areas are high. But the benefits of improvement, if the only alternative is operation on congested city streets, are also high. A recent study, for example, indicated that the initial cost of construction of 185 miles of urban freeways ($775 million) would be met by savings in vehicle operations in fewer than seven years if time savings of non-commercial users were included as benefits, and in fifteen years if not. No values were attached to added comfort and convenience of motorists.[3]

As population increases and incomes rise, continuing adjustments in the nature of our cities and in our patterns of living are inevitable. With increasing population and growing competition between central cities and their outlying areas, any effective rebuilding of our cities must surely include improvements in highway transportation facilities.[4]

Pertinent here is the comment of the Joint Economic Committee Staff: "In this age of potential H-bomb warfare, and in light of changed living habits and technological improvements, such as air transportation and the automobile, there would seem to be vast potentials for economically sound investment—perhaps in part by combined public and private authorities—in the rebuilding of the nation's cities, in decentralization, and in industrial dispersal." Any wide decentralization and industrial dispersal that may occur will, of course, increase our dependence on motor vehicle transportation.

With the exception of a relatively few really large and concentrated centers of population, it is believed that highway movements in urban areas will at least keep reasonable pace with increases in traffic generally. The extent of a less-than-proportional increase in highway movements at peak hours in the city center in the excep-

[3] City Engineer of Los Angeles, *A Study of Freeway System Benefits*, 1955.
[4] This is not to say that improvement in mass transit facility will not also be necessary.

tional case is likely to be more than offset by increases in traffic in non-peak hours and in residential and suburban areas.

The Ability to Finance Highways

In the light of engineers' inventories of needs, and of the independent and bolder anticipations of population, productivity, and motor travel given here, there can be little doubt as to the desirability of huge expansion of highway modernization programs. That is to say, there can be little doubt if the people can afford such programs.

At the risk of being considered a bit impish, one might observe that hardly anyone,[5] in presenting forecasts of vehicle ownership and highway travel, questions the ability of the American people to afford the vehicles, fuel, and other items for motor transport that must be acquired through the private sector of the economy. Serious concern seems to be expressed only as to their ability to provide and pay for the essential to efficient highway service that must of necessity be provided by government. This is the more surprising when it is noted that the former is likely to take nine or ten times as much of the highway transportation dollar as the latter, even under the most ambitious of suggested highway development programs.

Perhaps other considerations are more valid:

1. As an immediate proposition there is convincing evidence of much truth in the slogan that "good roads don't cost—they pay." Time and time again in considering individual highway improvements it has been shown that the benefits of tangible savings in motor transportation costs offset the cost of the highway improvement including interest. Estimates for improvement of an entire system of highways are necessarily rough, but reasonable approximations indicate that the penalties of inadequate roads are greater than the costs of providing good roads.

2. The increased population of the future may be expected to have the desire to obtain road space to meet its needs. Otherwise, the added population will have no place to operate vehicles except by crowding them onto already congested facilities, thereby further

[5] Exception should possibly be made for some of my more intense economic colleagues who profess to see in highway transportation a great waste and misallocation of economic resources in the light of its obvious high cost in comparison with mass movement.

increasing the social and economic costs of highway transportation. The increased population, of course, will be expected to acquire and pay for vehicles, fuel, and the like. If they can do this, they can also buy the necessary road space which will cost but a fraction as much.

3. In the final analysis, the effective demand for highway service is a function of the willingness to pay for it. We have suggested great increases in productivity and incomes, a lesser proportion of which will be necessary for the staples of life. There is little reason to believe that the people will be unable to devote a lesser share of their product and income to highway transportation service (including highway provision).

On the contrary, it seems likely that more of product and income will be willingly devoted to this service in the future to gain the advantages of greater safety, comfort, convenience, and savings in time spent in movement—all of which would require a vast expansion of highway modernization programs.

Current Efforts to Finance Highways

In spite of the present sad condition of the nation's highway plant as evidenced by its operational inefficiencies apparent to all, by the estimates of needs for its modernization, and by the clear prospect of great increases in the demands to be made upon it, it would be unfair to imply that the states and the national government have been idle. Federal aid for highways has increased with each new authorization since World War II. A number of states took action immediately after the war to increase their rates of highway financing. Gradually others joined the parade. Some made second-round increases. But the record was not at all uniform.

Between 1941 and 1954, thirty-five states had increased gasoline taxes—the major highway revenue producer—but thirteen had not. Among the states making increases, rates ranged from 13 percent to 67 percent except for one state that doubled its tax. The nationwide weighted average of state gasoline tax rates increased by 29 percent, but this was clearly insufficient in comparison with the 100 percent or better increase in construction costs and the greater capital costs for modern design. Much of the dollar increase in highway revenues

is simply the result of increased traffic and has been offset to a great extent by increased demands on highways of this very traffic.

When conventional methods of financing seemed incapable of meeting the problem, renewed attention was given to toll road possibilities in some areas of the country. By October 1955, there were 2,900 miles of toll roads in operation and under construction, representing a capital cost of $4.3 billion. An additional 5,600 miles were authorized which will, if they are built, cost nearly $7 billion. But at best, toll financing is generally regarded as a measure of last resort and even then its possibilities are severely limited in comparison with the over-all highway investment problem.

In any event, acceleration of conventional financing and toll road activity clearly were not meeting the problem (many areas were falling behind), when the President requested the development of a "grand plan" of highway modernization in mid-1954. Even while the President's program was under debate in 1955 the states did not stand idly by. Fourteen states increased fuel taxes, at least an equal number raised other user taxes, and sixteen states authorized highway bond issues in a total amount well exceeding a billion dollars. However, a number of other states were simply marking time until the federal picture was clarified.

National Highway Legislation of 1956

After great and healthy public debate, both in and out of Congress, the Federal-Aid Highway Act of 1956 was enacted into law in June of this year. Now the program as enacted does not provide for anything like the expenditure of $100 billion in ten years. Rather, it provides about $25 billion in *additional* federal funds over approximately thirteen years (if revenue estimates hold up, and apparent intentions as well as actual authorizations are carried out).

An outstanding feature of the act is the specific declaration of congressional intent to achieve "prompt completion of the interstate system"—that system of important roads consisting of a little more than one percent of the nation's highway and street mileage but which carries upwards of 15 percent of all motor vehicle traffic. Congress provided $25 billion for this system and the states will provide one dollar (less in a few states) for each $9 of federal funds.

Congress apparently intends to review authorizations for other eligible federal-aid systems (primary, secondary, and urban extensions) every two years, as it has for some time past. The 1956 Act made an additional authorization for 1957 and new authorizations for 1958 and 1959, which will provide $450 million more for the three years than would have been provided by continuation of the $700 million annual level for these systems established in the 1954 Act (in other words, the authorization for the three years is $2,550 million instead of $2,100).

Looking to the future for these systems, certain federal taxes which are now definitely linked to the federal highway program by the 1956 Act are continued to 1972. The revenues should provide leeway for future authorizations for these other systems at levels increasing at least $25 million annually, as has been proposed in the House version of the bill. Besides this, the financing of other highways can be greatly accelerated in many areas of the country because state funds now going to the interstate system will be released for other highway improvements.

Considering the total picture, I would estimate that the additional federal funds together with normal federal aid and a continuation of state and local financing will provide a grand total of highway construction funds on the order of $95 to $100 billion over the next thirteen years. But the impact of the 1956 Act is not to be measured alone by the dollars authorized for expenditure. Its enactment overshadows all other developments in highway finance in many years. The entirely new approach to federal highway financing made explicit by the legislation will have an overriding significance as long as highway transportation is important to our economy. We are well on the road to a national system of major highways, nationally financed through user charges, a course from which we are not likely to retreat.

The Commercial Approach. As finally adopted, the program is on a pay-as-you-go basis, depending on its own revenue sources, which are expected to raise about $38.5 billion over the next sixteen years. By recognizing certain taxes (on motor fuel, tires, and trucks) as highway-user charges and setting them aside in a special trust fund to meet highway expenditures, the national government is following

and affirming the basic policies of highway financing that have been developed and refined over the years by the several states. For all practical purposes the national government has turned to what some economists call a commercial basis of highway financing.

This approach under the new conception of federal responsibility for major traffic arteries is basically sound. It places the responsibility for highway improvements on the direct beneficiaries. When all is said and done, expanding highway use and the need to maintain and improve its quality gave rise to the problem.

The imposition of highway-user charges for financing a program of this nature performs useful objectives. First, highway-user charges promote equity. Highway use is measurable and is unevenly distributed among individuals and groups. There appears to be no more reason to provide major highways on a social welfare basis than there would be to provide vehicles and fuel.

Second, our transportation economy is made up of various competing elements provided by government and private enterprise in different degree. For optimum allocation of economic resources, as a general rule traffic and investment should be apportioned among transport forms on the basis of their relative economy and fitness. But this objective is possible only when the costs of publicly provided facilities such as highways are recovered from the users; otherwise distortions of investment and traffic result.

Third, and perhaps most important, user charges provide a rough test of the willingness of direct beneficiaries to pay for the facilities they require for safe, convenient, and economical transportation. Balanced development of highway facilities is somewhat more likely if users rather than general taxpayers are required to pay for these facilities.

On the one hand, the economic advisability of capital outlays for highways can be judged directly on the basis of benefits to users and their willingness to pay for them, and not in competition with other government projects which may have wider emotional appeal. On the other hand, the fact that users will be required to provide the funds should stimulate a closer evaluation of projects than might be the case if the funds came from general taxes that have no relationship to any function of government.

Some may be disappointed that no new principles of finance have

been developed or are suggested here.[6] In some quarters it will be regarded as unfortunate that the brunt of the national user-tax burden is assessed against one specific product—gasoline. But the intent is not to discriminate against the product. It just happens that gasoline consumption is the best single measure of highway use that lends itself to effective tax administration.

It is recognized that gasoline taxes need to be supplemented by other charges, not for the purpose of broadening the tax base, but to achieve a more reasonable and equitable distribution of the burden among users in relation to highway costs and use. It is to be noted that Congress provided for differentially higher taxes on commercial vehicles and has directed the Secretary of Commerce to study the entire problem with a view to making appropriate adjustments in the national user-tax structure.

In my judgment, the states have been following a sound practice in financing highways primarily on a user basis.[7] The nature and magnitude of the new federal effort in the highway field is such that it can no longer be rationalized as a program to meet special obligations and limited objectives of the national government. The program is intended to provide a system for optimum mobility of users; someone has said it is designed for "auto-mobility." It is appropriate, then, that the national government follow financial principles that the states have evolved.

Implementing the Program. On an over-all basis it is believed that the Federal-Aid Highway Act of 1956, together with a continuation of activity by state and local governments will provide about all the money for highway construction that can prudently be used over the next several years, perhaps for a decade or so, unless the value of the highway dollar is seriously eroded by the inflation of costs which lurks in the program. Effective implementation of the program, however, presents an important and immediate challenge to our administrators and the industries concerned with highway construction.

[6] We see no virtue in catering to an apparent fetish for "new sources" or "broader tax bases" unless the revenue structure is actually improved thereby.

[7] It is recognized that responsibility for financing a portion of the costs of multiple-purpose facilities, particularly when the main function is to provide land access, may appropriately be assessed against property or general taxpayers.

At a time when we already have reasonably full employment in most parts of the country, many things will be required in greatly increased quantities to step up highway construction to the rate hoped for—cement, steel, asphalt, construction labor, and construction machinery, to mention a few items. And even before these demands can be felt in full force, solution to the critical shortage of highway engineering personnel must be devised. An obvious need is to attract more engineers into the profession and to develop new leaders to carry on the program. More effective use of the engineers now available and full use of technological developments are clearly required.

In the initial years of the program while public agencies and private industries are gearing up, some hope is seen in the possibility of concentrating effort on right-of-way acquisition. Congress has wisely made provision for this effort which potentially can save millions. But preliminary engineering must locate freeways and expressways before rights-of-way can be acquired. Economic studies must be made, and public hearings held. In many areas of the country honest, if unwarranted, doubts persist as to the effect of access-controlled highways and urban by-passes on business and property values.

Also, the sheer magnitude of right-of-way requirements will necessitate the uprooting of untold numbers of homes and businesses. These considerations will result in sincere and vocal opposition that is bound to impede progress to some extent. Moreover, right-of-way negotiation itself requires skilled personnel, much of which will have to be recruited and trained.

Some Other Problems

These are but a few of the immediate problems in implementing the program. Other problems are of a more general nature and will continue to concern top-echelon policymakers at both the national and state levels. The 1956 Highway Act itself suggests the scope of Congressional interest, for it directs five specific studies to be made by the Secretary of Commerce, all of which have potentials for controversy. These include a study of the action that can be taken by the federal government to promote highway safety, a question

that is likely to have overtones with respect to relations between the states and the national government.

The problems of vehicle dimension and weight limitations and of equitable distribution of highway costs among classes of vehicles, each of which has been a perennial concern of state legislatures, are to be studied. Also, the Secretary is to make a resurvey of interstate highway needs and an analysis of facts regarding possible reimbursement to states for highways, whether toll or free, on the interstate system which have been completed since August 2, 1947, and which measure up to designated standards. Each of the last two warrants comment.

Total Interstate Needs. The 1956 Act states: "It is the intent of Congress that the interstate system be completed as nearly as may be practicable over a thirteen-year period and that the entire system in all states be brought to simultaneous completion."

One can guess that the new survey of needs is likely to produce a higher total figure for the interstate system than any we have seen so far. For one thing, quite a number of states have had little experience in the building of highways to the standards contemplated for the interstate system, especially in urban areas, and their 1954 estimates appear to be on the low side. In these states higher needs figures will probably be found; compensating reduction in needs figures for states having had more experience with the demands of modern design is hardly to be expected.

It may be noted also that the state-by-state estimate of needs made in 1954 totalling $23 billion for the interstate system did not include cost figures for approximately 2,300 miles of urban highways which have since been added to the system, bringing it up to the then authorized 40,000 miles. Rough provision was made for this mileage in the 1956 Act's total authorization of $27 billion (including state matching funds); but the Act itself authorized the addition of another thousand miles to the system (the Senate had proposed an addition of 2,500 miles), which eventually will be added to the costs of completion.

There is nothing magical in an arbitrary limitation of 40,000, 41,000 or even 42,500 miles, and it is to be anticipated that pressures will be exerted on Congress to add more mileage to the system, which,

if successful, will add to cost and require either extension of the program or additional financing.[8] Any reimbursement that may be made for previously completed mileage will have similar effect.

The fact that authorizations for highways not on the interstate system do not extend beyond 1959 can also affect the rate of completion of the interstate system. The law provides that funds for the interstate system are to be reduced for any year in which the remaining funds in the trust fund would otherwise be insufficient to meet appropriations for other highways. If future Congresses should increase authorizations in substantial amounts without providing additional financing, the impact would be felt on the interstate system and the stated objective of the 84th Congress might be defeated.

State-by-State Needs. The Senate apparently had little faith in the uniformity of estimates of needs on the interstate system submitted in 1954 by the individual states and reviewed by the Bureau of Public Roads. It rejected the House proposal for distributing interstate funds immediately on the basis of those estimates, but finally acceded after conference to adoption of the "needs principle" for apportionment after the proposed resurvey. For the three fiscal years, 1957, 1958, and 1959, the existing formula (two-thirds population, one-sixth area, and one-sixth post road mileage) is to be used.

Granted that the 1954 needs estimates may not have been entirely uniform, use of the old formula is likely to create some unfortunate results. States like Montana and Nevada, with large areas and low population and traffic volumes, may have considerable difficulty in matching and expending the funds that will become available. States like Vermont and Delaware, by virtue of the minimum percentages in the formula, may encounter similar difficulties.

In principle, difficulties will iron out as the needs basis becomes effective. But in the meantime an uneven rate of acceleration of state programs in relation to what they will ultimately be, and difficult readjustments for both industry and the highway departments are in prospect. Moreover, an area of uncertainty will continue for a number of years, making state planning difficult. One cannot be oblivious

[8] Those familiar with state problems are well aware of the constant pressures to add mileage to the system of highways under the direct jurisdiction of the state.

to the possibility that Congress will find itself embroiled in a new controversy if, as is to be expected, the resurvey indicates a material change in apportionments, not only from the existing formula, but also from one that might have been struck from the 1954 needs estimate.

Impact on Toll Roads. The matter of reimbursement for recently completed facilities on the interstate system poses a delicate problem of equity. In principle, reimbursement would correct a common injustice of new or expanded grant-in-aid programs, which tends to penalize the progressive states that have made efforts to meet their problems and to reward those who have lagged. But reimbursement would add substantially to the cost of the program. Besides, the states that have completed highways have already enjoyed the fruits of their use for some time.

Perhaps more important than the question of equity is the fundamental fact that the program as now written apparently deals a lethal blow to most toll-road development. Most of the remaining toll-road possibilities probably parallel interstate highways, which the federal government proposes to finance as free roads to the extent of 90 percent or more. Toll roads, of course, cannot compete successfully with nearby free roads built to the high standards planned for the interstate system.[9]

It is fair to note that there was evidence of a decline of interest in toll financing before the recent federal legislation. Under the current principles of toll financing, full liquidation of costs from tolls without state or federal tax subsidy is ordinarily required. Under this requirement the most clearly feasible toll roads had been or were being built. It was becoming increasingly difficult to find new routes that could be financed by tolls, particularly in the face of an expanding mileage of modern free roads which generally provided the advantages of toll roads without the disadvantages. Moreover, some fiscal problems, as in the West Virginia and Ohio situations, were beginning to dampen toll-road enthusiasm.

While it may now be water over the dam for the years immediately ahead, certain adaptations of toll financing might have given

[9] It is not unlikely that some cases will be found where toll financing will still be feasible and desirable, but any extensive development seems quite remote.

new life to the movement. For example, the use of state and federal tax funds to support a portion of toll-road costs might have been found advisable. The "all or nothing-at-all" principle requires a given project to be 100 percent toll financed or 100 percent tax financed. But any fraction of the cost of a project (over the special costs caused by the total method) defrayed by tolls would reduce the tax requirement and thus would release user-tax funds for other highways.

As a matter of simple equity, the least that might be done is to allocate to the toll facility the user taxes generated on it when such additional support would make toll financing feasible. In other cases, the toll *system* concept might have been encouraged. Successful toll roads might have supported others which showed a lesser margin of safety than investors generally require.

In short, the integration of user-tax and toll financing under conditions carefully defined to prevent abuse might have been evolved to meet a part of the highway financing problem. The possibilities are not to be overlooked if the present program falls somewhat short of meeting the mark set for it by its leading enthusiasts.

General Fiscal Policy. The fact that Congress rejected the President's original proposal for a credit program in favor of pay-as-you-go financing is understandable in the circumstances. Congress, concerned with the problems of economic stabilization, could not overlook the fact that deficit financing would feed the fires of inflation. On the other hand, the treatment of highway financing on a commercial basis is a new venture for the national government. Refinements of policy are to be expected in the future. The establishment of the trust fund offers some interesting possibilities for coordinating general fiscal policy with highway finance policy.

The commercial approach to highway financing clearly suggests the use of credit under certain conditions. In the private sector of the economy, the use of credit is a matter of course in the provision of long-lived capital facilities. Purchasers of goods and services are expected to pay prices that yield amounts sufficient to cover a return on the investment and its amortization over its useful life. Since highway facilities are long-lived, a spreading of cost over time promotes equity among users and neutrality among carriers.

The absence of close identity of users over time fortifies the case for assessing economic costs rather than expenditures against users; ordinarily this may be done only through the use of credit. But the logic of this approach appears to be in direct conflict with a stabilizing budget policy that calls for budget surpluses in prosperity and tolerates deficits in depression.

The conflict might be reconciled by a policy permitting the general treasury to make advances to the highway trust fund for capital expenditures.[10] Such advances would be arranged in the light of general fiscal policy at the time. That is to say, during full employment advances would be made from current revenues; if employment conditions indicated the advisability of deficit financing, advances to the trust fund would be made from borrowings. Collections from highway users for the trust fund would be fixed to approximate the costs of highway construction, that is, to meet depreciation and interest. Over time, the plan would call for full reimbursement including interest to the general treasury for all advances.[11]

The Role of the States

The national program for development of the interstate system is not intended to displace state activity in the provision of highways. After all, the interstate system consists only of some 41,000 miles of a total plant of 3.3 million miles. Cost-wise, the interstate system accounts for some $27 to $30 billion of the $101 billion reported in the most recent inventory of needs. States and localities have the responsibility for preparing all construction programs, including those on the interstate system, and for all maintenance, policing, and operation of the entire highway plant. State and local agencies will bear the brunt of the difficult problems in implementing the enlarged program provided by the Federal-Aid Highway Act of 1956 which were mentioned earlier.

While we have said that the 1956 Act, along with continued state

[10] Actually, the financing proposals of the House went a little way in this direction, for trust fund deficits during the middle years of the program were to be met by treasury advances which would have been repaid with interest. The Senate, however, insisted on strict pay-as-you-go financing. It is recognized that any program along the lines suggested above should be managed with extreme circumspection.

[11] A beneficial by-product might result from the channeling of any emergency funds through established highway machinery, instead of through relief programs as was done so extensively during the depression of the 1930's with consequential losses to the economy.

and local financing, may provide on an over-all basis about all the money that can prudently be used for a number of years, it is more difficult to generalize as to the impact of the program on the states individually. Some of the states which have relatively small mileages and costs on the interstate system, and others who have lagged in adjusting their highway programs to current realities, may still be faced with the need of accelerating their highway programs through additional state and local taxes or by the use of credit.

Other states—perhaps a majority—will face problems of a quite different nature. With large amounts of federal funds available for interstate highways which they had previously been financing in substantial measure, these states may find it desirable to reallocate their own funds among highway systems under their jurisdiction or to increase state aid to local governments for roads and streets.

A desirable alternative in some instances may be an enlargement of mileage under the direct jurisdiction of the state. But whatever action is taken, it should only be done after careful appraisal of the alternatives. Unwarranted dissipation of state and local funds in the face of the new-found prosperity is to be guarded against, for it might well nullify the great co-operative effort to meet the over-all highway problem, which is implicit in the 1956 Act.

The states will carry most of the responsibility for satisfying their residents as to the desirability of controlled-access highways and urban by-passes, a problem which as suggested earlier is likely to raise unpleasant controversies in many parts of the country. Some of the states have had little experience in dealing with freeway and expressway location in large urbanized areas.

Another Look at the Future

Additionally, more effort will have to be exerted in all quarters to improve the operational features of our new modern facilities. Unsolved problems are to be found in such matters as proper signing, control of excessive speeds and other bad driving practices, the removal of disabled vehicles, and the like. All of these threaten to seriously impair the efficiency of our best designed highways.

A tremendous step in meeting highway challenge is promised in the years immediately ahead by the enactment of the Federal-Aid

Highway Act of 1956. But the act itself does little more than provide the funds and the framework in which to use them. Making effective use of the funds is the challenge now passed to administrators and others concerned with highway affairs.

A realistic appraisal of our highway transportation problems compels us to warn against any illusion that the ultimate solution is now within grasp. The word "completion" itself as used in connection with any highway system may be an unfortunate choice. Highway transportation is and will continue to be dynamic. The future is bound to create new challenges.

A few comforting aspects show up in the highway picture of the next quarter century or so. The rate of increase in the incidence of vehicle ownership is expected to level off to some extent. The number of two-car families is likely to increase but at a reduced rate. Even more slowly, if ever, are we going to reach any considerable level of three- and four-car ownership families; and if we do, the mileage driven per vehicle will probably decline.

Another factor to be noted is that highway capacity must be provided in "lumps." Highways cannot be widened inch by inch. When two-lane highways are converted to modern four-lane facilities, much more than a doubling of capacity is accomplished. Evidence of this lumpiness is seen in the engineering estimates of accruing highway needs referred to earlier. For the next ten years it is said that expenditures should average $10 billion a year, but for the following twenty years the average is only $5.7 billion.

More impressive is the fact that the annual average for the interstate system (without recent additions) is $2.3 billion for ten years, but is less than half a billion for the ensuing twenty. Moreover, the modern high-capacity facilities now contemplated for construction will be protected for traffic mobility and against premature obsolescence by limitation of the rights of access.

Some little comfort may also be derived from the fact that operating speeds of motor vehicles have leveled off. Then, too, by size and weight limitations we are attempting to hold highway vehicles to the capacity of highways, rather than trying to outrace the vehicle designers. We obviously cannot allow our highways to become totally obsolete every few years by raising design standards to accommodate larger, heavier, and faster vehicles.

This is not to say that we have reached the optimum combination of highway and vehicle design. Nor would it be desirable to hold back indefinitely possible progress in highway transportation by arbitrary restrictions on vehicle design dictated by current practices of highway design.

No one can know all that technological developments may hold in store, but a mere listing of a few possibilities that are now quite feasible—for a price—is impressive. Buckley suggests some of these: One-way freeways and expressways; separate roadways for commercial vehicles; separated lanes for specified speeds with points of interchange between; removal of disabled vehicles by helicopter; built-in highway illumination making headlights unnecessary; automatic elimination of snow and sleet as it hits the pavement; electronic devices built into highways and vehicles to control the smooth, safe flow of traffic, monitored by closed circuit television.[12] Developments along these lines will make today's most modern highway seem obsolete tomorrow.

The economic problem will be to test the effective demand for the new-type facilities. The costs will be great even for a limited mileage of tomorrow's highways; hence, rigorous application of the commercial principle will become increasingly important. Two simple examples may give meaning to the issue.

First, it might be found that building certain highways to accommodate larger and heavier vehicles (or possibly building separate facilities in some cases) will actually reduce the costs of highway carriage (including the highway costs). The reduced costs of commercial vehicle operation would offset the added costs of highway provision. Market calculations would apply under the commercial concept, and the added highway costs would be assessed against the vehicles responsible; but they could well afford to pay since their total costs would be less.

For a second illustration, take an extreme case involving savings in non-commercial time which must be subjectively evaluated. Suppose that a new vehicle and a redesigned highway, both with electronic controls, would permit safe operating speeds of 120 miles an hour instead of 60. Savings in time for non-commercial users would

[12] J. P. Buckley, "Highways of the Future," a paper presented on Panel "Transportation Horizons Unlimited," University of Michigan, July 12, 1955.

neither reduce money costs of transportation nor contribute to the national product, but they clearly might have value for which the users would be willing to pay.

If enough value is attached to the time savings, economic justification of the project might be found under present methods of analysis. It might be concluded that "120-mile per hour speedways don't cost—they pay."[18] The basic economic question is whether the time saving is worth the allocated cost to each motorist. If it is estimated to be so, the users should be expected to pay for it. Provision of this kind of saving can hardly be regarded as a general obligation of government.

These simple examples point up the fact that major facilities under modern concepts of design are rapidly becoming single-purpose instruments for the provision of optimum mobility to users and economically must be evaluated as such. Highways of the future are likely to be given over even more to providing the ultimate in speed, economy, efficiency, comfort, and convenience for highway users. They are likely to include features that quite properly may be classed as luxuries.

In our thinking about highway transportation we have gone through stages: at first motor vehicles were regarded as toys of the rich, as displays of conspicuous consumption. Then we began to recognize the usefulness of highway transportation and came to regard it as a necessity. I wonder whether we shall not see the day—if indeed we are not already seeing it—when certain features of our vehicles and of our highways must again be considered in the luxury class.

This is not to say that luxury features should not be provided. It is to say that it should be put up to the users as squarely as possible whether they want to buy highway improvements, just as it is now up to them to decide whether they want to buy automatic shifting devices, power brakes, power steering, air conditioning, and other embellishments which may make vehicle operation more pleasurable, but are hardly necessities.

[18] For 100 miles of road carrying 50,000 vehicles a day and with time valued at two cents a minute per vehicle, an investment of $315 million would be justified under the assumptions (with 30-year amortization at 4 percent interest). The question is whether the time saving is worth a dollar to each vehicle user.

John F. Fitzgerald Expressway
Boston Central Artery

LEO F. DEMARSH

Mr. DeMarsh has been employed on the Central Artery project since 1949 and for the last two years has been Project Manager in charge of location and design. He joined the Massachusetts Department of Public Works in 1946 after overseas duty with the U. S. Army Corps of Engineers. Mr. DeMarsh is a member of the Massachusetts Highway Association and the Boston Society of Civil Engineers and is an officer in the Transportation Section of the latter organization. He was recently appointed a member of the City Planning Board of Brockton, Massachusetts where he resides.

THE FIRST section of the John F. Fitzgerald Expressway—also known as the Boston Central Artery—was opened to traffic in October, 1954. During 1955 other parts were opened, until now the length of expressway extending from the Mystic River Bridge in Charlestown to Fort Hill Square in Boston, a distance of 1.6 miles, is in use.

For reference purposes in this discussion, the portion now in use is called Section I; the next part, under construction and extending through downtown Boston from Fort Hill Square to Kneeland Street, a distance of 0.7 mile, is called Section II; and the remaining 1.5 miles from Kneeland Street to Massachusetts Avenue, which is in the design stage, is termed Section III.

A central artery for Boston, although not becoming a reality until recent years, is not entirely a new idea for the relief of the city's traffic ills. On the contrary, it has been talked about for many years and has been the subject of engineering reports by various groups dating back thirty to forty years or more.

One of the more complete reports—prepared in 1930 by Robert Whitten, a consultant for the city planning board—proposed among other improvements an elevated highway running from the north end of the city to the south end. It is of interest to note that the route followed today closely coincides with that proposed in 1930.

To serve as a quantitative basis for the highway planning of the

Whitten report, a complete and detailed traffic analysis and forecast were prepared through the joint effort of the Mayor's Street Traffic Survey, the Boston Planning Board and the Division of Metropolitan Planning. This traffic study's purpose was to determine the origin and destination, volume and distribution of traffic, and also a forecast of future traffic growth.

The city was divided into twelve districts; these, together with the thirty-eight cities and towns in the metropolitan area surrounding Boston, made a total of fifty traffic districts. Volume counts were made at control points within the traffic districts, and origin and destination checks within the city were made by the Boston police department.

In addition to the above studies, travel-time studies were made on all traffic routes in Boston proper and on the sixteen main routes radiating from central Boston. The travel-time studies immediately showed the inadequacy of existing routes and provided a basis for estimating the savings in time and vehicle-operation costs for users of the proposed new routes.

The improvements recommended in the Whitten and other reports of that era were not carried through to construction; first, because of the depression that followed and second, because of the shortage of manpower and materials during World War II. Nevertheless, many of the ideas developed then served as a basis for formulating the 1948 master highway plan which is the guide used today in developing the expressway system of metropolitan Boston.

Master Highway Plan

In compliance with Governor F. Bradford's directive of August 9, 1947, a joint board was organized for the purpose of preparing a master plan of highways for the Boston metropolitan area. This board, consisting of the Commissioner of the State Department of Public Works, the Commissioner of the Metropolitan District Commission, and members of the State Planning Board, submitted to the Governor on February 1, 1948 its report recommending an expressway system and listing the estimates of cost and the economic justification for constructing it.

The master highway plan was based on a comprehensive origin

and destination survey made in the fall of 1945 by the Department of Public Works in co-operation with the Public Roads Administration, Federal Works Agency. This survey consisted mainly of obtaining travel data through home interviews and supplementing them with an external survey made by traffic counts and roadside interviews. The O and D study was divided into two phases as follows:

1. Internal Survey, including
   a. Selection of samples for homes, trucks and taxis
   b. Home interviews
   c. Truck interviews
   d. Taxi interviews
2. External Survey, comprising
   a. Traffic counts
   b. Roadside interviews

To obtain complete information on traffic movements, each city and town in the study area was divided into zones, which were further subdivided into sectors of two or three city blocks. For the purpose of the report, the zone was used normally as the smallest subdivison; however, the O and D counts were coded both by zones and sectors, and the sector data are used today quite often for determining exact ramp locations in the detailed location studies.

From the traffic data obtained, desire-lines of travel were plotted on maps and these lines formed a basis for general route location of expressways. The major desire-lines connecting Boston with the outlying communities indicated that eight radial expressways were needed. Furthermore, these major desire-lines entered Boston tangent to the downtown area and this fact indicated that a Belt Route encircling the downtown area was needed. (Figure 1.)

The proposed Belt Route, with a diameter of about three miles, serves as a terminus for seven of the eight radials. This permits the Belt to perform a double function, serving through-traffic from one radial to another and also serving traffic destined for the downtown areas. The master plan also proposed that the Belt should be supplemented with an adequate system of surface streets to facilitate the movement of vehicles between the expressway system and the downtown districts.

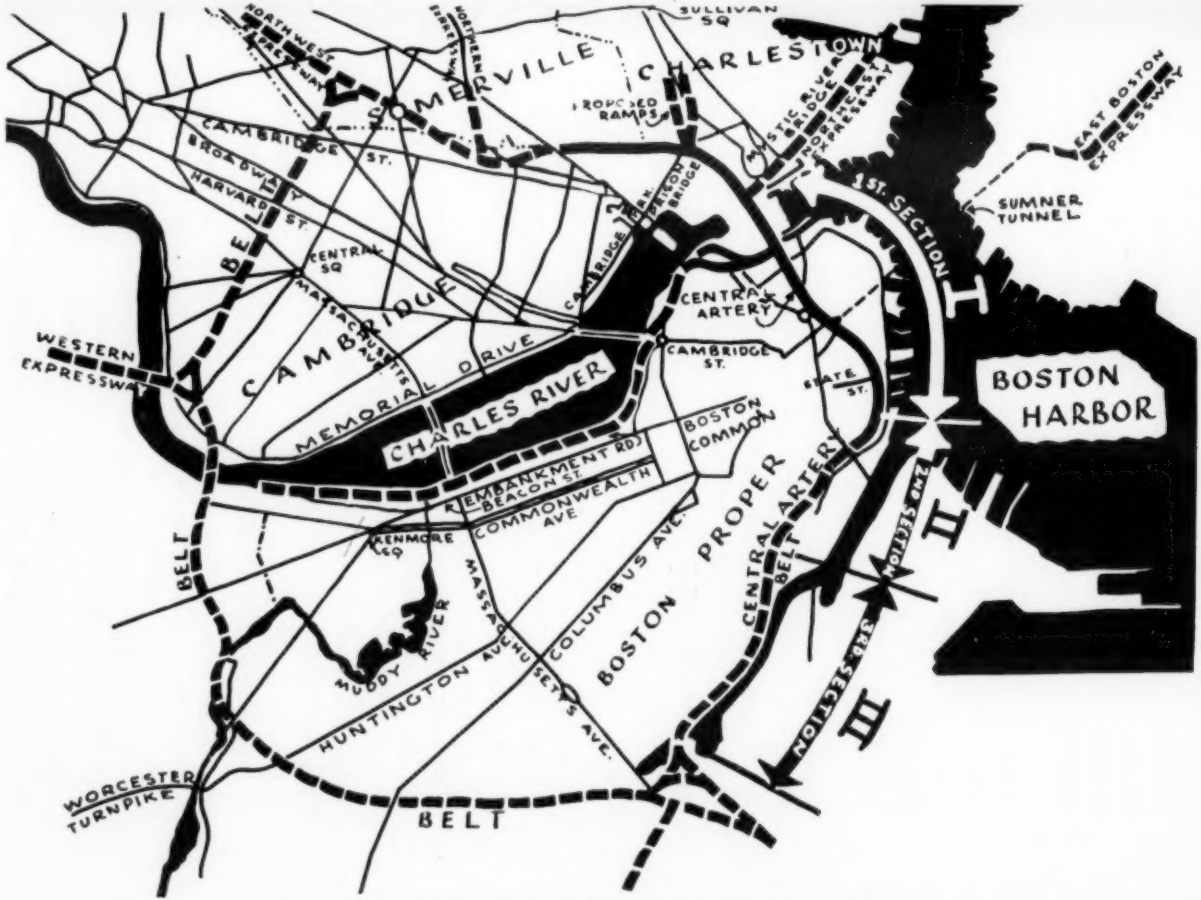


FIGURE 1. Boston's proposed Belt Route encircles the downtown area.

Perhaps the most important arc of the Belt is the John F. Fitzgerald Expressway and this section received first priority in the construction program. As previously mentioned, part of the expressway is open to traffic and other sections are either under construction or in the planning stage. The remainder of the Belt Route has not been programmed as yet.

The expressway system proposed in the master plan was sound–it was based on measured needs–and the routes indicated therein, although intended to show only a concept, were all feasible from a construction viewpoint. The 1948 estimates of cost for the Belt and radial routes, including construction and rights-of-way, totalled $322,000,000.

This figure for the 87.4 miles of expressway proposed would, of course, have to be revised upward to meet present day costs. The cost of the system was too great to be borne by the city and it became necessary for the State Legislature to pass "An Act Providing for an Accelerated Highway Program" in 1949, as the all-important step in transforming plans into reality.

Financing and Cost of Project

The 1949 Act authorized the state to issue bonds in the amount of $100,000,000 to finance the accelerated highway program. Subsequent bond issues in 1950, 1952 and 1954 brought the total to $550,000,000, which was to be used on projects throughout the state, and of this amount, the State Department of Public Works was authorized to expend a sum not to exceed $203,000,000 for projects set forth in the master highway plan for the Boston metropolitan area. The master plan was referred to specifically in all of the bond issue acts.

Section 10 of the 1949 bond issue Act reads as follows:

> To meet the expenditures necessary in carrying out the provisions of this act, the State treasurer shall, upon request of the Governor and Council, issue and sell at public or private sale bonds of the Commonwealth, registered or with interest coupons attached, as he may deem best, to an amount to be specified by the Governor and Council from time to time but not exceeding in the aggregate the sum of one hundred million dollars.
>
> All bonds issued by the Commonwealth as aforesaid shall be designated on the face: Highway Improvement Loan, Act of 1949, and shall be on the serial

payment plan for such maximum term of years not exceeding ten years from the date of issue, as the Governor may recommend to the General Court pursuant to section 3 of Article LXII of the Amendments to the Constitution of the Commonwealth, the maturities thereof to be so arranged that the amounts payable in the several years other than the final year shall be as nearly equal as in the opinion of the State Treasurer it is practicable to make them.

Said bonds shall bear interest payable semi-annually at such rate as the State Treasurer with the approval of the Governor shall fix. Such bonds shall be payable not earlier than July first, nineteen hundred and fifty-one, nor later than June thirtieth, nineteen hundred and sixty three. All interest payments and payments on account of principal on such obligations shall be paid from the Highway Fund; provided, that notwithstanding the foregoing, such obligations shall be general obligations of the Commonwealth.

The later bond issue acts were patterned from the first.

While to date Sections I and II of the John F. Fitzgerald Expressway have been financed entirely from funds made available by the several bond issues, it is anticipated that for Section III, which is now in the design stage, federal funds may become available.

The total cost of Section I is about $55,000,000, and of this amount $15,000,000 is for right-of-way. Section II, now under construction, will cost about $20,000,000 for construction and $10,000,000 for right-of-way. The remainder, Section III, from Kneeland Street to a proposed interchange in the southerly end of the city, is estimated at $15,000,000 for construction and $5,000,000 for right-of-way.

Location and Design Features

The primary function of the Central Artery became obvious when the origin and destination traffic survey indicated that 85 percent of the drivers entering Boston had business within the downtown area; or in other words, only 15 percent could be considered by-pass traffic. It was established, therefore, that the purpose of the Artery was to serve as a collector and distributor of traffic, making the downtown districts more readily accessible by motor vehicles.

Consequently, to fulfill its purpose and to function efficiently the Artery should be located as close to the high desire-areas as reasonably possible; furthermore, ramps should be provided in sufficient number and in proper location with respect to the expected traffic

volumes and the high desire-areas. This, of course, is a basic consideration and has to a great extent guided policy regarding expressway location throughout the length of the project.

While it was readily established that the expressway was to serve as a collector and distributor of traffic, it was quite another matter to locate the facility so that it could perform its intended function properly. The complete lack of regular pattern for Boston's old streets presented many problems in location.

The crooked, narrow lanes, many of which were laid out in the seventeenth century, were anything but conducive to the integration of an expressway with the existing street system. Unlike a city with a rectangular street pattern where ramps could connect with existing parallel streets, the ramps of the Central Artery especially in Section I had to be custom-tailored to fit existing conditions. Some were bent at right angles to the expressway and others curved to fit the contour of an important feeder street.

Furthermore, the large number of ramps required to handle the expected volumes–sixteen in Section I–presented difficulties in itself. Considering this number of ramps in 1.6 miles of expressway, it can be seen that if the location of one ramp were altered it could in many instances upset the entire arrangement. In other words, it was not possible to consider ramp locations independently of each other.

The following criteria were used as a guide for route selection:

1. The main expressway must be a six-lane, limited access, divided highway.

2. The number and location of ramps must be such as to serve fully the traffic desires.

3. Consideration should be given to the possibility that terminal facilities (parking areas) and improvements of the street system can be provided.

4. The selection of the route must be based on an over-all consideration of all pertinent factors, including the following:

   a. Functional adequacy.

   b. The over-all beneficial effects on properties, businesses and industries in the areas immediately adjacent to the expressway and in other areas the expressway is intended to serve.

   c. Special consideration must be given to minimize the impact

of the project on integrated groups—such as the garment, and the shoe and leather trades.

d. Initial and ultimate effects on city tax revenues.

e. Cost of operation of vehicles using the expressway system.

f. Annual maintenance and operating cost of the expressway and ramps.

g. Appearance of expressway.

In addition to the above criteria, the following geometric design standards were adopted:

General: Conform with "Interstate" standards of the American Association of State Highway Officials.

Design Speed: Expressways, 35 mph.
Ramps, seven-tenths of expressway or 25 mph.

Minimum Radii:		
	Expressways	400 feet
	Ramps, at expressway connection	200 feet
	Ramps, remainder	80 feet
	Curb radius, surface connections	50 feet

Super-elevation: Per AASHO, but not in excess of one-half inch per foot.

Pavement Widths: Number of lanes provided on expressway in accordance with master plan recommendations (three lanes each direction). All ramps to be two-lane. Paved width, 12 feet per lane plus a two-foot offset to curb on each side; i.e., 40-foot width, curb to curb, for three-lane and 28-foot width for two-lane roadway.

Vertical Clearance: 14 feet, plus three inches to allow for future resurfacing.

Lateral Clearance: Dimensions from outer edges of expressway lanes to objects such as abutments or columns: Right side, 6 feet from edge of traffic lane. Left or driver's side, 4.5 feet from edge of traffic lane.

Gradients: Expressways, 3.0 percent or under preferred; 4.5 percent maximum. Ramps, 5 percent or under preferred; 6 percent maximum.

Prior to adopting the above standards, it was necessary to ascertain or predict the traffic load the facility was being designed to accommodate, and too, the distribution of this load through the various hours of the day. Also, the percentage of trucks and other commercial vehicles destined for expressway travel had to receive consideration in view of the effect of the larger vehicles on gradients and clearances.

The O and D survey, on which the master plan recommendations were based, indicated that the estimated 1970 traffic volumes on portions of the Artery would be approximately 90,000 vehicles per 24-hour day; of this amount it is anticipated that about 15 percent will consist of commercial vehicles. With these traffic data in mind and considering that the short length of expressway was to include many ramps—each ramp contributing weaving or merging movements to the normal flow of traffic—it was decided that a design speed no greater than 35 mph should be adopted.

Another factor that set design speed by dictating curvature on some portions of the expressway, was the practical necessity for avoiding entirely certain buildings of importance. While the design speed is 35 mph, actually speeds much greater than that are attainable on straightaway sections of the highway during certain periods of the day.

Natural Obstacles Governed Alignment

The preceding criteria and design standards were set up to guide location and design, but in addition, objects of man or nature also governed both horizontal and vertical alignments of the expressway. In Section I at the northerly end of the project, two massive columns of the Mystic River Bridge had to be relocated and the transverse spans extended to provide space for the northbound expressway connection. It was, of course, desirable that these alterations to the newly completed bridge be held to a minimum. Further, it was required that the expressway connection be made without disrupting the operations of the facilities of the adjacent U. S. Naval Shipyard.

The next obstacle was the elevated rapid transit structure in City Square which had to be spanned, causing the expressway profile to be raised to the 4.5 percent maximum. The roadways, on separate

structures both northbound and southbound, were spread farther apart at this point to permit the future construction of a "Y" type interchange above the freight yards of the Boston and Maine Railroad. Just beyond the interchange area both roadways converged to a double-deck structure for the crossing of the Charles River.

The river crossing was made on a 375-foot span, double-deck Warren truss bridge which has a vertical clearance of fifty feet above mean high water. In the early studies the clearance requirement was set at ninety feet and if this figure had been held it would have seriously affected expressway profiles.

On the Boston side of the river, the limited distance between the piers of the bridge and the thirteen-story Industrial Building controlled the geometry of the approaches to the branch which connects the main expressway with Storrow Drive, a recently-constructed surface highway running parallel to the Charles River. (Figure 2.) At the branch connection, the roadways of the main expressway come out of a double-deck structure and in a transition length of about one thousand feet, the roadways are placed side by side on a single deck structure twenty-five feet above surface streets.

The route of the single-deck structure continues above Haymarket Square, past the entrance of the Sumner Tunnel, thence through the market section to Fort Hill Square in the insurance and financial office district. The Sumner Tunnel passes under the harbor, connecting East Boston with Boston Proper. It carries more than 30,000 vehicles daily and in view of its importance as a traffic facility, it seemed desirable to provide expressway connections to it.

The objective was to furnish a complete set of four ramps—that is, on and off ramps in both directions—which would permit full interchange of expressway, tunnel and local traffic. The existing conditions presented an interesting and rather complex problem in location and at least twenty-four studies were developed before the final selection was made.

Schemes that favored expressway flows to and from the tunnel, created awkward and circuitous patterns for surface movements tunnel bound. On the other hand, plans that proved advantageous for surface traffic, imposed severe penalties on ramp grades and alignments. A compromise plan was finally developed making use of existing streets for a large rotary traffic system.

FIGURE 2. Branch connection off main expressway leads to Storrow Drive.

From the northerly end of the project at the Mystic River Bridge to the Sumner Tunnel, the existing street pattern made it impractical to construct surface roads parallel to the expressway and usually these roads form a very necessary part of an expressway system. However, beginning at the Sumner Tunnel and running southerly to the end of Section I, the expressway location and design permits the construction of a dual, surface-highway directly under the elevated structure. The new surface-roads—each thirty-four feet wide, separated by a ten-foot median—will facilitate the movement of traffic to and from the ramps and they will also supplement expressway capacity during peak periods.

In this section several cross streets were encountered and it has been the policy not to make any of these dead-end streets. They either pass under the expressway undisturbed or in cases where ramp walls created barriers, new roads were constructed connecting the otherwise dead-end streets and thereby providing continuous traffic circulation.

Design Features of Section I

Aside from the double-deck portion, the typical roadway cross section of Section I consists of two forty-foot roadways separated by a raised median four feet wide, with sloped curbing on both sides of the median and a steel pipe rail barrier centered along its full length. (Figure 3.) At two places on the expressway where entrance and exit ramps are in close proximity to each other, an additional twelve-foot width of pavement is provided to accommodate weaving movements, making the total pavement width of each roadway fifty-two feet at these locations.

The concrete roadway deck is covered with a two and one-half inch riding surface of bituminous concrete and at each outer edge there is a steel curb and guard rail assembly. Mercury vapor luminaires attached to steel standards set in the line of the guard rail furnish the highway lighting.

Fire alarm boxes are set along the roadway at convenient intervals and four-inch dry pipe lines are installed which can be connected to hydrants at street level and activated in case of fire on the expressway. Destination signs, with letters of white reflectorized buttons on

a green background, bridge the expressway in advance of ramp openings and similar signs, of a confirmatory nature, are placed directly above ramp openings.

Shoulders—or perhaps a better term would be breakdown lanes —were not provided on the elevated expressway because of the high cost of construction and rights-of-way that would be involved. Furthermore, the need for breakdown lanes is somewhat minimized because the frequent ramp openings at expressway level afford disabled vehicles some refuge from through-traffic. (Figure 4.)

The lower portions of ramps in Section I which are on earth fill between concrete retaining walls—a length of 400 feet or so—are radiant-heated to melt snow as it falls and thus provide safe braking areas on down ramps and sure acceleration on up ramps. Steam, piped from the mains of the public utility company in the surface streets, passes through heat exchangers to warm an anti-freeze solution which is then circulated through pipe grids embedded in the concrete pavement. This is perhaps the largest installation of its kind made to date; the heated area totals about 140,000 square feet.

World's Widest Vehicle Tunnel in Section III

Section II, now under construction, begins at High Street (near Fort Hill Square) where the elevated expressway swings into a natural route between two existing streets, Atlantic Avenue and Purchase Street. These streets, of adequate capacity and good alignment, are conveniently adapted to the expressway system as parallel one-way service roads. This is one of the few locations where existing streets could be incorporated in the system.

At High Street the elevated expressway immediately descends and continues downward until it meets a tunnel, which begins at Congress Street and runs a distance of 2400 feet through the downtown business districts to Kneeland Street. The tunnel which is really a big box, will be constructed by the "cut and cover" method and is perhaps unique in one respect—that on and off ramps will furnish access and egress at strategic locations along the route.

Also, it is believed to be the widest vehicular tunnel in the world, containing two three-lane roadways each forty feet wide in its normal section; where on and off ramps are closely spaced, an extra ten-foot

FIGURE 3. A view of Section 1 toward the south shows median barrier and ramps to surface streets.

FIGURE 4. Aerial view shows full length of Section 1, looking north.

FIGURE 5. Drawing of Section 2, looking south, visualizes route now under construction.

lane is provided in each roadway to accommodate weaving traffic. As is usually the case in underground construction in urban areas, the tunnel requires extensive relocation of many underground utilities —sewer, water, gas, electric, telephone lines and others, as well as alterations to the rapid transit station under Dewey Square.

The tunnel walls will be tiled and lighting will consist of a continuous line of fluorescent tubes placed on the ceiling near the walls of each roadway. Exhaust ventilating fans will remove contaminated air from the tunnel. Provisions have been made for the future installation of a television monitoring system that will enable a single attendant situated in the control building to view traffic conditions throughout the length of the tunnel at all times. In case of an emergency the attendant could dispatch aid to the scene or take whatever corrective measures were needed.

In the first half-length of the tunnel, two existing streets will form the parallel service roads; in the tunnel's second half-length, these two streets will merge with a dual surface-highway that will be constructed directly above the tunnel, thus forming continuous frontage roads. The highway design standards for the tunnel section of expressway are similar to those for the elevated portion except that ramp widths have been narrowed to reduce the amount of property-takings in areas of high valuation. The on-ramps will be twenty feet wide, and the off-ramps which are on an ascending grade will be twenty-four feet wide to allow more freedom for passenger cars to pass heavier, slow moving commercial vehicles.

There are many items of interest about the tunnel portion of the expressway—the maze of underground utilities that had to be unravelled and relocated; the detailed studies in ramp location based on sector traffic data; the ventilation system; the special problems in lighting created by the great width of the multi-lane tunnel and its ramp connections, and other items. It is expected that Section II of the expressway, most of which is underground, and its eight ramps will be completed in the summer of 1958. (Figure 5.)

Remaining Section of Artery in Three Years

Section III of the Artery, now under design, begins at the Kneeland Street end of the tunnel. Thence on an ascending grade it passes

through a railroad yard where it requires the removal of two large freight houses. The expressway rises above main-line railroad tracks and the Broadway Bridge on a viaduct structure and follows along a narrow strip of land bordered on the west by Albany Street and on the east by Fort Point Channel.

The route continues along this strip, crossing over the Dover Street Bridge and the channel to a "Y" type interchange in the south end of the city near Massachusetts Avenue. The interchange, also in the design stage, will provide connections to the Southeast Expressway—one of the radial routes partly under construction—and to the future extension of the Belt Route.

Like the other expressway segments, Section III will have on and off ramps connecting it with surface streets; actually ten ramps will be provided. On the west side of the expressway the adjacent Albany Street will form a parallel one-way service road; on the east side a new one-way frontage road will be constructed to handle the opposite traffic movement.

With respect to location, the problems in the two preceding sections were not present in Section III; the route to follow was more clearly indicated for this portion than for the others. The more important considerations in this section, which is just beyond the downtown business district, were (1) the necessity for keeping the main-line railroad tracks in operation and also for minimizing the dislocation of freight storage tracks, and (2) the desire to retain two main surface arteries, Broadway and Dover Street, which cross the path of the expressway. Construction on Section III may get under way late this year, depending on the availability of funds.

In reviewing location and design of the Central Artery's full length, it can be said that the criteria established for guidance were followed as closely as reasonably possible. It was not practical to comply fully with all requirements or principles for route location.

For example, placing the expressway along the line of the very heaviest desires, would incur prohibitive costs in rights-of-way. On the other hand, removing the highway to areas of lowest valuation would destroy its efficiency as a modern traffic artery whose purpose was to serve the business areas. The location finally selected was based on a consideration of all factors, with each given proper weight to achieve a satisfactory balance.

To meet traffic requirements, the three and three-quarter miles of expressway will be provided with thirty-four on and off ramps, each located strategically with respect to high desire-areas. Wherever feasible, parallel surface roads will be included in the system to afford the transition between expressway and city streets.

In considering the effect the type of construction might have on adjacent properties, it was believed that while an elevated structure would be quite acceptable in some sections of the city, such a structure would have a detrimental effect on property values in other areas.

It was decided, therefore, after careful study of various routes and a detailed comparison of elevated versus underground expressways, that the Artery should be placed underground through the major business center between Congress and Kneeland Streets which is in Section II.

Also in line with the established criteria, special consideration was given to minimizing the dislocation of closely integrated groups or interests. In one portion of Section II, the route was literally threaded between the buildings of the garment district and those of the leather trades, causing the removal of less than ten percent of the total floor area of each industry.

Inasmuch as the expressway will increase the demand for vehicular parking spaces, mention should be made of the off-street parking program. There is every indication that the program, under the jurisdiction of the City of Boston, will be broadened to meet the increased demand. At present the city plans to build several garages in close proximity to the expressway and it is possible that one of them will be built directly above the roof of the expressway just north of Dewey Square.

In addition, private capital has entered the picture, with one garage now under construction and the planning of another—cage-type facility—already on the drawing boards. Although it is not within the province of the State Department of Public Works to construct off-street parking facilities, the department is cooperating to the extent possible by making areas under or adjacent to the expressway available to the city for parking sites. Several such areas are now furnishing parking spaces for hundreds of vehicles on a metered basis.

Congestion in Boston, as in other major cities, is not new; with increasing vehicle registration over the years, its complexity has multiplied to the point of grave concern. Various reports list losses attributed to congestion, and while opinions vary widely on what costs can be charged to it, few doubt that traffic congestion has had a detrimental effect on property values in business districts.

The assessed valuations for Boston's Ward 3, which includes the central business district, decreased from 693 million dollars in 1926 to 450 million dollars in 1950, a loss of about 35 percent. It is generally accepted that the decline is due in great measure to the reduced accessibility arising from the inability of city streets to cope with large traffic volumes.

In 1941 Boston's mayor sized up the situation as follows: "Unless we can, as a start, relieve traffic congestion which exists within our city and unless we can provide facilities for business terminals and parking of motor vehicles, we shall make no progress in the rehabilitation of Boston."

Benefits Derived from Expressway

A good start has been made to untangle the traffic snarl in Boston. And although completion of the Artery will probably not solve all of Boston's traffic problems, nevertheless, it is believed that it will correct a major defect in the city's street pattern by providing a continuous north-south limited access way.

With only one section of the Artery in operation at present, its benefits to expressway users are already apparent. About 120,000 vehicles use a part or the full length of Section I daily and in the most heavily travelled portion of the expressway the average daily volume is about 65,000 vehicles. Trips that formerly required eighteen to twenty-five minutes on city streets are now made in two or three minutes via the expressway. The savings in time can be readily translated into savings in money due to lower vehicle operational costs and, at least in the case of commercial drivers, a definite hourly rate can be applied to the time saved.

In addition to the benefits enjoyed by expressway users, recent counts on surface streets in the vicinity of the expressway indicate that surface traffic has been reduced 40 to 60 percent, thus enabling

these streets to perform their normal functions more efficiently and to the advantage of abutting business establishments.

As other sections of the expressway are opened to traffic, the benefits to users and the city in general will of course increase. Additional ramps will penetrate high desire-areas or connect with streets that lead to these areas, permitting vehicles to reach their particular destinations with minimum travel on city streets.

Furthermore, because of the large number of ramps provided, the expressway will, to some extent, serve as a local vertical by-pass of certain busy surface intersections. One such location is at Dewey Square where a pair of ramps is provided just north of the intersection and the complementary pair just south of it.

It is confidently expected that the expressway and new surface roads will promote a redevelopment of properties made more easily accessible by the system. At present a new office building with parking facilities within it is under construction adjacent to the highway layout in Section II. In the area of Section III, buildings which have outlived their economic usefulness are now being demolished to make way for an industrial site under the urban redevelopment program of the Boston Housing Authority.

Of vital importance to this redevelopment is the Central Artery which, with a complete set of four ramps abutting, will provide excellent transportation service to the area. This industrial development of about fifteen acres is already underway. On the east side of the proposed expressway location, Fort Point Channel, a waterway recently declared non-navigable, offers a potential site of much greater proportions. Throughout the last several decades various governmental agencies have urged that the channel be filled and the area used for civic and industrial developments. It is fair to assume that completion of the expressway will hasten the reclamation and development of this area.

At the very southerly end of the Central Artery project, in the vicinity of Massachusetts Avenue and Southampton Street, a new market area is rapidly developing. The first buildings erected within the last few years house wholesale market firms that were required to move from the old market district to make way for construction of Section I of the expressway. Undoubtedly, completion of the Artery and the Belt Route will prove of tremendous benefit to the

new market district, bringing it within minutes of the various districts of the metropolitan area.

With the construction of the Central Artery well under way the face of Boston is rapidly changing—new buildings are being erected, industrial and market sites are planned and some have reached the development stage; other areas of vast proportions are available for reclamation and further development. The gigantic Central Artery project has of course required the taking of a great amount of taxable properties; however, it is believed that the initial losses incurred will be replaced by taxable new developments and increased valuations fostered by the orderly and efficient traffic pattern the Artery is developing.

Precedent For Broad Traffic Powers Set by Court Rulings in Baltimore

MAYOR THOMAS D'ALESANDRO, JR.

Mr. D'Alesandro has been Mayor of Baltimore since May, 1947. He is president of D'Alesandro and McCullough, Inc., Insurance. He was elected to State House of Delegates, Maryland, in 1926, and served two terms until 1933. He served on the Baltimore City Council from 1935 to 1938. In 1938, he was elected to the United States Congress and re-elected in 1940, 1942, 1944 and 1946.

BALTIMORE'S office of Traffic Director was created by ordinance number 786 of the mayor and city council in July, 1953. The new office took the place of a five-man traffic commission that had handled traffic matters in Baltimore since 1950. The commission type of administration did not satisfactorily solve the problem. Actually it proved almost as difficult and cumbersome to deal with as the regular legislative agencies of the city. It was, therefore, decided to reorganize the department, place authority in the hands of one individual, and abolish the commission.

Ordinance number 786, setting forth the duties, responsibilities, and authority of the traffic director, is presented in full. The authority of the director under this ordinance is extremely broad. Section K gives the director broad powers over the regulation of vehicles and pedestrians. In fact, the only power retained by the mayor and city council is that of creating one-way streets and general parking regulations. All other matters, such as regulation of pedestrians, trucks, the installation of signs, signals, markings, and other functions are the responsibility of the traffic director. The director receives an administrative appointment from the mayor, and, therefore, cannot be discharged, except for cause, over a four-year tenure.

City Solicitor's Opinion

In 1955, the state legislature adopted a statute permitting local municipalities to regulate speeds on their thoroughfares, except for

roads maintained by, or extensions of, federal or state highways within incorporated cities, villages or towns.

Since Baltimore is a home-rule city and therefore has somewhat autonomous powers to regulate traffic, plus the fact that the State Roads Commission of Maryland does not in any way control or maintain highways within the City of Baltimore, it was the opinion of the city solicitor that there are legally no state roads or extensions of any in Baltimore. Therefore, the regulation of speed would be the responsibility of the traffic director on all streets and highways in Baltimore.

A local taxpayer entered suit against the traffic director and the mayor and city council to restrain them from regulating local speeds, maintaining that the city did have extensions of state or federal highways, and therefore, could not legally exercise authority over such streets. The complainant attacked the entire ordinance creating the office of the traffic director, stipulating that the ordinance usurped the authority of the police commissioner, and, therefore, was illegal. He asked that the court restrain the traffic director from exercising any control over traffic without the explicit approval of the police commissioner.

Ruling in Favor of Mayor and Council

This case was thoroughly argued in The Circuit Court of Baltimore before Judge Moser (Docket 1955-A-392-A-3541). In September of 1955, this court ruled in favor of the mayor and city council, except in one instance where the regulation promulgated for the control of speeds stipulated the amount of fine for violating the order. The court held this was a function of the court and not the traffic director. We fully agreed, because if the traffic director were to establish fines in the case of speeding, it would be incumbent upon him to set the amount of a fine for violating any of the other many directives of his department.

The suing taxpayer appealed to the Maryland Court of Appeals. That court held during April, 1956 that the delegation of authority by the mayor and city council to the traffic director for the regulation of traffic was a proper delegation of authority; in fact, a desirable one. The opinion pointed out that the complexities of modern day

traffic are such that it is unrealistic to depend on the slow process of legislative action to correct many traffic matters of urgent, or emergency nature.

The only exception in the appeal ruling was that the court believed that while the state did not maintain any highways through Baltimore, there are, in fact, marked extensions of state and federal highways into and through the city, and while the regulation of speeds by the state on some streets—the city regulating others—did not seem a proper method of control, still they could only interpret the law as written, and, therefore, must hold that the city could not regulate speeds on streets marked as state or federal highways. All other questions in the appeal were held in favor of the mayor and city council.

Re-Hearing Denied

The same taxpayer requested a rehearing by the Court of Appeals, arguing he had rendered a service to the people of Baltimore by exposing the illegal expenditure of public money by the traffic director through the installation of speed signs on *one* state highway within the city limits. He told the court it was, therefore, unreasonable that he should be assessed his cost for the appeal. The court unanimously refused the rehearing.

This decision of the Court of Appeals probably gives broader powers to the traffic director in his field than has been given to almost any other appointed state or municipal official with the exception of the health commissioner. In fact, the court drew a strong parallel between the responsibility of the traffic director and the health commissioner as they both intimately affect the health and welfare of the community. The text of the ordinance follows:

Baltimore City Ordinance Number 786

An ordinance repealing and re-ordaining, with amendments, Sections 1 to 9, inclusive, of Article 38 of the Baltimore City Code (1950 Edition), title "Traffic Regulations," sub-title "Traffic Commission," abolishing the Traffic Commission of the City of Baltimore, and creating in lieu thereof the office of Director of Traffic of the City of

Baltimore, and delegating to, and imposing upon, said Director of Traffic certain powers and duties; providing that certain designs, drawings and plans be submitted to said Director of Traffic for review and recommendation; transferring certain employees of the Traffic Commission of the City of Baltimore to the office of Director of Traffic of the City of Baltimore as employees thereof upon certain conditions and authorizing and directing the City Service Commission to do certain things in connection therewith, providing that certain appropriations for the year 1953 be credited and made applicable to the office of Traffic Director of Baltimore City; making it unlawful for any person to do certain things and providing penalties for violations thereof, and repealing certain ordinances and regulations in force in the City of Baltimore; and changing said sub-title to be "Director of Traffic."

WHEREAS, prior to the adoption of this ordinance, the Board of Estimates of Baltimore City has recommended the creation of a special office to be known as the "Director of Traffic of the City of Baltimore"; now, therefore

Section 1. Be it ordained by the Mayor and City Council of Baltimore, That Sections 1 to 9, inclusive, of Article 38, of the Baltimore City Code (1950 Edition), title "Traffic Regulations," sub-title "Traffic Commission," be and the same are hereby repealed and re-ordained, with amendments, to be under the new sub-title "Director of Traffic," and to read as follows:

Director of Traffic

1. (a) In order to provide for the safe and expeditious movement of traffic in the City of Baltimore, and to protect the safety of the citizens using its streets, there is hereby created an office of the Mayor and City Council of Baltimore, to be known as the "Director of Traffic of the City of Baltimore." The head of such office shall be the Director of Traffic of the City of Baltimore, who shall be appointed by the Mayor of Baltimore City in the manner prescribed by, and subject to the provisions of, Section 12 of the Charter of Baltimore City.

(b) The Director of Traffic of the City of Baltimore may adopt

such rules and regulations as he may deem necessary for the proper transaction of his business. The Director of Traffic of the City of Baltimore shall keep records of his proceedings. The Director of Traffic of the City of Baltimore shall keep a record of all resolutions, transactions, findings, determinations and decisions, and all the records of the Director of Traffic of the City of Baltimore shall be kept in the office of the Director of Traffic of the City of Baltimore and shall be public records.

(c) The Director of Traffic of the City of Baltimore shall perform such duties as may be imposed upon him by ordinance or as may be assigned to him by the Mayor of the City of Baltimore. The Director of Traffic of the City of Baltimore may appoint, employ, hire or engage such other assistants, aides and employees as may be deemed necessary for the proper performance of the duties and functions of the Director of Traffic of the City of Baltimore. The compensation of said Director of Traffic of the City of Baltimore and other assistants, aides and employees shall be subject to the approval of the Board of Estimates and shall be paid as provided in the annual Ordinance of Estimates.

(d) The Director of Traffic of the City of Baltimore, subject to the prior approval of the Board of Estimates, also may employ or hire, from time to time, by contract, consulting, planning or designing engineers or other persons possessing technical or specialized skills in connection with the duties, powers and functions of the Director of Traffic of the City of Baltimore.

2. The Director of Traffic of the City of Baltimore be and he is hereby granted full power and authority and directed to do any and all of the following:

A. Collect and analyze all physical and economic data needed to measure existing, and to estimate future, street and highway traffic characteristics and needs, including parking needs.

B. Conduct engineering analyses of traffic accidents and engineering investigations of traffic conditions.

C. Prepare and submit to the Mayor of Baltimore City an annual

report of the progress and operations of the Director of Traffic of the City of Baltimore.

D. Make recommendations to the Mayor and the City Council of Baltimore for the improvement of traffic conditions in the City of Baltimore, which cannot be accomplished by the directives, orders, rules or regulations promulgated by the Director of Traffic of the City of Baltimore, as authorized by Sub-paragraph K of Section 2 of this Ordinance.

E. Hold such public hearings as, in his discretion, may be necessary in connection with the exercise of his powers, as set forth in Section 2 of this Ordinance; such hearings to be held and conducted in the manner determined by the Director of Traffic of the City of Baltimore.

F. Establish and determine the design, timing, type, size and location of any and all signs, signals, markings, pylons, channels and other devices for guiding, directing or otherwise regulating and controlling vehicular and pedestrian traffic.

G. Designate any intersections as "STOP" intersections or through highways.

H. Approve or disapprove the location of bus stops designated by The Baltimore Transit Company, or its successor, or rescind or modify any prior approval heretofore given.

I. Have and exercise all control over traffic that the Police Commissioner for the City of Baltimore had prior to the time this ordinance becomes effective, including the power to establish special "NO PARKING" spaces; provided, however, that the Director of Traffic of the City of Baltimore shall not have the power to make and enforce special regulations with regard to traffic as set forth in Section 87 of this Article.

J. Install and maintain such traffic signs, signals, markings, pylons, channels and other devices as heretofore or hereafter directed by ordinance or heretofore directed by the Police Commissioner for Baltimore City.

K. Adopt and promulgate rules, regulations, orders and directives relating to, or in connection with, the movement of vehicular and pedestrian traffic in the City of Baltimore.

However, the Director of Traffic of the City of Baltimore shall not have the power to adopt and promulgate rules, regulations, orders or directives in the nature of general parking restrictions or to establish one-way streets; the power to make general parking restrictions or to establish one-way streets is specifically reserved to the Mayor and City Council, to be exercised by them by ordinance.

3. All designs, drawings and plans prepared by any department or agency of the Mayor and City Council of Baltimore for the construction or location of any public building, park or recreational area, or other structure which may affect the movement of traffic in the City of Baltimore, shall be submitted to the Director of Traffic of the City of Baltimore for review and recommendation before any actual construction operations are commenced, and in all cases where designs, drawings or plans are submitted to any department or agency of the Mayor and City Council of Baltimore in connection with an application for a permit or authorization to construct or locate any proposed privately owned building or structure, including, but not limited to, any off-street parking facility or garage to be used by the public, which may affect the movement of traffic in the City of Baltimore, the department or agency of the municipality receiving such designs, drawings or plans shall immediately notify the Director of Traffic of the City of Baltimore upon the receipt of such designs, drawings or plans so that the Director of Traffic of the City of Baltimore may have an opportunity to review such designs, drawings or plans and make recommendations relative thereto.

4. (a) All of the present employees of the Traffic Commission of the City of Baltimore be and they are hereby transferred to the office of Director of Traffic of the City of Baltimore as employees thereof.

(b) The City Service Commission is hereby authorized and directed to classify all positions transferred as aforesaid from the Traffic Commission of the City of Baltimore to the office of the

Director of Traffic of the City of Baltimore and all employees so transferred shall be included in the new classifications of their respective positions without examination and without any reduction in pay.

(c) The aforesaid transfer of employees from the Traffic Commission of the City of Baltimore to the office of the Director of Traffic of the City of Baltimore shall not operate to deprive such employees so transferred of any rights that they may have in the Special Fund or Special Fund for Widows of the Police Department of Baltimore City.

(d) Any former employees of the Traffic Bureau of the Police Department heretofore transferred to the Commission and who are hereby transferred to the office of the Director of Traffic, as aforesaid may, however, prior to January 1, 1954, elect to become a member of the Employees' Retirement System of Baltimore City, under such rules and regulations as the Trustees of said Employees' Retirement System shall provide, including the right of withdrawal of his contributions to either or both of said Special Funds and depositing the same with the said Employees' Retirement System; and any employee so electing to become a member of said Employees' Retirement System shall thereafter have no further rights in the said Special Police Funds. Any employee so transferred who elects not to become a member of the said Employees' Retirement System shall be entitled to pensions, benefits or allowances for himself, his widow or dependents under the laws or ordinances in force immediately before the adoption of this ordinance.

5. All unexpended balances of the appropriations for the year 1953 for the support, operation and maintenance of the Traffic Commission of the City of Baltimore shall be credited to and be applicable to the support, operation and maintenance of the office of the Director of Traffic of the City of Baltimore created under the provisions of this ordinance.

6. All assistants, aides and employees appointed or employed by the Director of Traffic of the City of Baltimore as provided in Section

1 of this ordinance (except the present employees of the Traffic Commission of the City of Baltimore, who are to be transferred to the office of the Director of Traffic of the City of Baltimore as employees thereof as provided in, and subject to the terms of, Section 4 of this ordinance) and except such consulting, planning or designing engineers or other persons possessing technical or specialized skills in connection with the duties, powers and functions of the office of the Director of Traffic of the City of Baltimore who may be employed pursuant to the provisions of Section 1 of this ordinance after May 23, 1951, shall be appointed or employed in accordance with the provisions of Sections 142 to 156, inclusive, of the Baltimore City Charter (1949 Edition).

7. (a) It shall be unlawful for any person, without lawful authority, to wilfully deface, injure, move or interfere with any sign, standard, post, safety zone, semaphore, tower, automatic signal, or any other traffic device, or any part thereof, erected by the authority of said Director of Traffic of the City of Baltimore, or any directions, lines or marks painted by the authority of said Director of Traffic of the City of Baltimore on any pavement, curb or roadway for the purpose of directing traffic or parking vehicles;

(b) It shall be unlawful for any person to fail, neglect or refuse to comply with any instruction or direction on any post, standard, sign or other device erected by the authority of said Director of Traffic of the City of Baltimore for the regulation of traffic or parking on public highways;

(c) It shall be unlawful for any person to violate any rule, regulation, order or direction promulgated by said Director of Traffic of the City of Baltimore, as hereinbefore provided; and

(d) Any person violating any of the provisions of this Section 7 shall be guilty of a misdemeanor and, upon conviction thereof in any court of competent jurisdiction, shall be fined for each and every offense not more than One Hundred Dollars.

8. Any and all laws, ordinances and regulations and any and all parts of any and all laws, ordinances and regulations in force in the City of Baltimore inconsistent with the provisions of this

ordinance or with any rule, regulation, order or directive hereafter promulgated by the Director of Traffic of the City of Baltimore, as hereinbefore provided, are hereby repealed to the extent of any such inconsistency, and any and all laws, ordinances and regulations and any and all parts of any and all laws, ordinances and regulations in force in the City of Baltimore not inconsistent, amended or superseded by the provisions of this ordinance or any rule, regulation, order or directive hereafter promulgated by the Director of Traffic of the City of Baltimore shall remain in full force and effect.

9. In case it be judicially determined that any word, phrase, clause, item, sentence, paragraph, section or part in or of this ordinance, or the application thereof to any person or circumstances, is invalid, the remaining provisions and the application of such provisions to other persons or circumstances shall not be affected thereby, the Mayor and the City Council hereby declaring that they would have ordained the remaining provisions of this ordinance without the word, phrase, clause, item, sentence, paragraph, section, or part, or the application thereof, so held invalid.

Section 2. And be it further ordained that this ordinance shall take effect from the date of its passage.

Approved July 14, 1953

Stretching the Transportation Dollar

WAYNE FRANCIS PALMER

Mr. Palmer is president of Palmer and Baker, Inc. of Mobile, Alabama and Texas, Gulf South Utilities, Inc. Some of their engineering projects, in addition to those discussed in the following article, include four-lane tunnels under the harbors of Havana, Cuba and Gothenburg, Sweden; two for the Florida state highway department at Fort Lauderdale; another at Galveston, Texas, and the Southern Louisiana Turnpike. During Mr. Palmer's service in World War I, he presented the Navy with one of two fundamental designs for magnetic mines. Between 1918 and 1921, in charge of of the mine laboratory at the Washington Navy Yard, he acquired a total of seventeen patents, all but two for Naval use. After 1921 he served as vice-president and general manager of the Palmer Steel Company of Springfield, Massachusetts for ten years; as a member of the firm of Snyder and Palmer, consulting engineers, and since 1938 as president of Palmer and Baker, Inc. Mr. Palmer is a member of the American Society of Civil Engineers, the Society of Naval Architects and Marine Engineers, the Society of American Military Engineers, and other organizations. He is author of "Men and Ships of Steel" and "Hell Ship."

IT IS NOT LONG since motorists along the Gulf Coast were subjected to alternate jouncings along secondary highways and long delayed ferry trips. For instance it was a two-day trip from Pensacola, Florida to New Orleans, with a long, slow ferry trip across Mobile Bay; a second one at Pascagoula, Mississippi; a third at Biloxi; a fourth at Pass Christian, and a fifth one to reach New Orleans.

Step by step these ferry intervals were closed, but it was not until the depression era that the Gulf Coast started actually to emerge from the aftermath of the Civil War's retardation and entered into the promised economic land of the United States that it is today. It has been said that the South lost the war but won the depression. Certainly the depression period marked the turning point for this potentially rich and favored area.

Transportation has been one of the Gulf Coast's chief problems–its coast line indented by bayous and its rivers ending in multiple-exit deltas. This area, while rapidly advancing, was and still is of

limited population and limited resources, while possessing an overabundance of mileage–often through sparsely settled areas. So much is needed to make up for long inadequate facilities that transportation had to be worked out with ingenuity and Scotch thrift.

In 1938, it was proposed that an east-west tunnel be built as a part of US 90 under the Mobile River directly into downtown Mobile across the open end of a seven and one-half mile hairpin-shaped highway that wandered into the city from the north. The proposal set the citizens aghast. Never before had a tunnel been built south of the Mason-Dixon line. The residents of the city in the paralysis of the depression could not envision the accomplishment as possible either physically or financially.

That in fact was the studied verdict of its chamber of commerce; but the city commission, deciding that the best way to get rid of a disruptive element was to pass a resolution, authorized application to the Public Works Administration and the Reconstruction Finance Corporation for construction funds totalling four million dollars. There it was assumed the project would die. An editorial in a now defunct newspaper said it was in favor of the tunnel so that its proponents could more easily get out of town and leave the city to "its well-earned repose."

It was soon found that there was interest in Washington but there was much skepticism. Nevertheless, with the aid of the Reconstruction Finance Corporation and many admonitions from Secretary Harold Ickes, on December 16, 1938 a commitment was made by the RFC to lend $2,500,000 against revenue bonds and by Secretary Ickes to grant $1,500,000.

That was all the money there was, because this was the last project in the program to be approved and the barrel had been scraped clean. Furthermore, under the law construction had to be started before midnight December 31, 1938, fifteen days later. Secretary Ickes advised that he would not approve construction until it could be demonstrated that the project could be built inside of four million dollars.

At the time of receiving the commitments, completed drawings consisted of one sheet. Yet on December 31st, the first contract for utility relocations had been advertised in accordance with the laws of the State of Alabama and awarded. It was based upon detailed

plans and specifications. On that date nearly one hundred men were at work; but when they had been photographed ripping up a section of the streets and tearing out curbing, and when the job had been certified as legally started, the work was shut down for several months until it could be carefully organized.

Keeping the Cost to $4 Million

Then the question was faced: How to build the tunnel for four million dollars. Secretary Ickes' commitment was specific: There was no more money; if it could not be shown by actual bids that it could be built within funds available, then there was no deal. The city could not help with the first dollar because it was too deep in the grip of the depression.

Concurrent with this tunnel construction, Queens Midtown Tunnel in New York City was being driven under the East River. Analysis of construction cost for its 15,265 feet of roadway at $3,800 per foot indicated that a driven tunnel was out of the question because of the greater depth at which it must go to provide cover for the high pressure necessary to advance the shield and because of the high cost of the shield itself. Borings at Mobile indicated an excellent bearing material of coarse white sand, and this confirmed the impression that a trench tunnel was the only answer.

The last previous trench tunnel was the Detroit-Windsor tunnel. This had been completed in 1929 and indicated a cost per foot from grade point to grade point at $3,484.

Limited on the east by the open waters of a tributary of Mobile Bay and on the west by the threat of injunction proceedings by property owners, the total over-all length of 3,400 feet was a forced determination. With maximum cash available of four million dollars and a length of 3,400 feet, the problem was to meet a cost of $1,170 per foot.

Then a demand by shipping interests and the Army Engineers for tunnel top depth of forty-five feet across the river channel and a fixed depth at pier head lines, made a ramp grade of six percent mandatory. This was in rank violation of all previous tunnel design, but it was either that or no tunnel.

One marked economy, developed on this project, was the use of

longitudinal rather than transverse ventilation. Air was drawn in at the portals along the roadway, through outlets at the curb line for the center 400 feet of the tunnel; and thence drawn by air ducts under the roadway to the one ventilation building and exhausted out of the ventilation-building stack. This saved a dual supply-and-exhaust system of fans, relieved the project of the cost of an overhead air duct, and further markedly reduced operating costs.

Engineering Problems in Building Tunnel

One added requirement for the tunnel was occasioned by the maximum available elevation of three feet at its eastern portal; in 1926, however, flood waters at this point stood at elevation 9.6 feet. It was necessary to cover and protect the tunnel section up to grade point and to provide the portal with massive steel doors designed to seal it off in case of high water. All had to be built strong enough to withstand the battering-ram effect of floating logs on hurricane waves.

Into the sandy soils lying below the muck cover of the area, a trench was dredged across the river while a sheet pile wet cofferdam was built into the city to receive the seven steel tubes forming the basis of the tunnel. These tubes, built at a nearby shipyard, were double hulled; the inner cylindrical hull provided watertightness and form against which the tubes were lined with eighteen inches of reinforced concrete to provide the strength ring. The octagonal outer hull forms for mass concrete gave the tubes negative buoyancy.

Each tube was completed except for the tile and electrical installations before submergence. The tubes were sunk successively, joined together; the whole construction operation was completed and the tunnel was opened to traffic on February 21, 1941, just twenty months after the actual start of construction.

The tunnel was named the Bankhead Tunnel after Senator John Bankhead, father of the late Senator John Bankhead and Speaker William Bankhead, in recognition of his having sponsored the first Federal Highway Act.

No sacrifice to economy was permitted in safety features and appearance, and in the fifteen years of operation the maintenance costs have been nominal. It is the only subaqueous vehicular tunnel that is known to be without any leaks.

In initial financing it was estimated that 1200 cars a day could be expected to pay tolls, and this would assure the financial integrity of the bonds. A toll of twenty-five cents was set for private cars, with a higher cost for trucks and buses. It was estimated that if the number of cars dropped below 780 per day the bonds would go into default; but year by year, totals have climbed to 12,500 a day as the forty millionth car now pays its toll.

All of these, without the first accident to person or property, speed under busy Mobile River without a minute's delay to waterborne or vehicular traffic. Sometimes the Bankhead Tunnel is referred to as the "safest half-mile" and other times as "Mobile's Fort Knox."

Financing the Tunnel

Three times the bonds have been refinanced, the last time in 1955 for seventeen million dollars. The profits from this venture have been sufficient to complete the paving and attendant storm drainage for every unpaved street in the City of Mobile. A surplus of seven and one-half million dollars now exists awaiting the start of construction of the second Bankhead Tunnel tube in anticipation of traffic demands—in spite of wide predictions in its early days that "no one would ever use the tunnel even if it were possible to build it."

One of the outstanding reasons for the financial success of this project was the establishment of the tunnel on a sound economical ownership basis. No special commission was created. Legally it has been considered an extension to beautiful old Government Street. The City of Mobile Commissioners have merely added the responsibility of the tunnel to their other duties.

The tunnel police, although the tolls pay for their work, are a part of the city police department. The city auditor handles the accounts. The city attorney assumed his new duties in connection with the tunnel. That is the way it was originally established, and it has never changed. Time has proved the soundness of simplification.

Tunnel A Model for Later Projects

In spite of the success and economies of the Bankhead Tunnel, it was determined by its designers that the cost of operation might limit the

use of tunnels in the less affluent communities of the South. So when the Washburn Tunnel at Pasadena, Texas, was projected by Harris County for construction under the Houston Ship Channel, two distinct improvements and economies were incorporated.

In general, this two-lane tunnel used the same basic design as the Bankhead Tunnel but the incandescent lighting previously used in all subaqueous tunnels was discarded because of a zebra-like impression as one drove through, with their alternating light and dark bands. Continuous cold cathode slim line lighting was used from portal to portal, giving four and one-half times the candle power on the roadway over that previously used and at less power cost. Further incorporated into this tunnel were the first steps towards automatic operation to reduce the number of employees required to be in continual attendance.

The four 375-foot trench tubes were built at Pascagoula, Mississippi, and towed 500 miles to Pasadena, Texas. This tunnel, with a tunnel top depth of forty-five feet under the channel, was 3,791 feet long from grade point to grade point and was built at an over-all cost of $2,000 per foot.

The Belle Chasse Tunnel under the Intracoastal Canal across the Mississippi River from New Orleans has just been opened for traffic by the Louisiana State Highway Department. It was built in cooperation with United State Army Engineers and the Parish of Plaquemines.

This project is unique in that it is fully automatic and is designed to operate without any attendants or policing. The ventilation fans automatically adjust the ventilation as required by the volume of traffic. As a safety standby, carbon monoxide analyzers are ready, in case of a threatening increase in this noxious gas, to throw on more fan capacity as necessary. All pumps are automatically operated, again with standbys that will not only work if one of their number is out of order, but are so regulated that they take turns doing the job to distribute the wear.

In case of loss of power, the tunnel diesel generator automatically starts and goes on the line; but in the instant before it is fully functional–so that there can be no period of darkness in the tunnel–storage batteries always on the line insure lighting. Sun meters control the amount of lighting used in the tunnel, adapting it to actual

requirements and thereby establishing marked economies. No restriction on the use of the tunnel by any vehicles, except those overheight, is attempted.

Automatic Features in New Tunnels

In case any piece of equipment is out of order an indicator board outside of the ventilation building so notes and the state police, on their regular patrol duties, can report by car radio to their headquarters in the district. But chances are that a similar reporting board in police headquarters will already have relayed the information to the state highway electrical maintenance man, who can make the necessary repairs. There need be no hurry because standby equipment has already assumed the task of its crippled mate.

A further unique feature of this tunnel is that it was built in the dry in an open field, and after completion the waterway was dredged over the top of the tunnel. This tunnel is 1,933 feet from grade point to grade point and cost $1,230 per foot.

Nearby under the Harvey Canal–another unit of the Intracoastal Canal on the other side of the Mississippi River from the City of New Orleans–the state highway department is completing a four-lane box type trench tunnel which is being built in conjunction with the Federal Bureau of Public Roads and Jefferson Parish. This tunnel incorporates all of the automatic features of the Belle Chasse Tunnel and is being constructed in the dry by means of cofferdams built one-half way across the canal, one of the busiest waterways in the United States.

The tunnel is already completed to the center of the channel, and without bulkheading the open end of the tunnel at mid-channel the cofferdam is being partially removed to allow water traffic to pass over the completed section. With the tunnel still dry the cofferdam will be completed at the other bank, and the tunnel completed to join up with the open ramp section and those portions of the tunnel sections already completed on the opposite bank.

This tunnel measures 2,295 feet from grade point to grade point. With a total of 4,590 feet of roadway, its cost is $950 per foot of roadway.

For a century the people of south Louisiana stood on the shores

of Lake Pontchartrain and dreamed of the day when it would be bridged from its north to south shores. In 1952 legislation finally indicated hopes could become realities.

A 24-Mile Bridge Across Lake

The task of designing this—the longest bridge in the world—meant the assumption of much responsibility, but it also meant an intriguing challenge. This 24-mile bridge would stretch for one-thousandth of the distance around the world. If it were built across the English Channel and started at the White Cliffs of Dover, the other end would fall four miles inside France.

If its deck were kept level and did not follow the contour of the earth and took off tangent at one shore, it would be 380 feet high at the opposite shore. If the bridge did follow the earth's curvature, it would be 1.46 inches longer at deck level than at the water line. And finally, in planning for expansion there was a 132-foot variation between summer and winter temperatures.

Two major problems were involved in determining the exact location of the bridge. The first was selection of a route and determination of the bridgeheads on the north and south shores of the lake. Location was based on traffic studies, including origin and destination surveys at strategic points on the main highways around the lake.

The location recommended was from Harlem Avenue in Jefferson Parish on the south shore, where the Parish owned an unused 180-foot right-of-way extending from the lake to the Mississippi River. This intersected US 90 near the Huey Long Bridge over the Mississippi River, thereby intersecting this vital transcontinental highway. At the north the bridgehead was placed near Mandeville. Plans were made with the aid of the State of Mississippi to extend a modern feeder road to Jackson, Mississippi, intersecting US 190, 84, 80 and 51, thereby enabling this toll facility to tap the principal routes of the Gulf Coast area.

The second problem was to pinpoint the location of the bridge precisely on the earth's surface by triangulation. While the United States Coast and Geodetic Survey had established a good triangulation network around three sides of Lake Pontchartrain, it had never

FIGURE 1. Washburn Tunnel and approaches under the Houston Ship Channel.

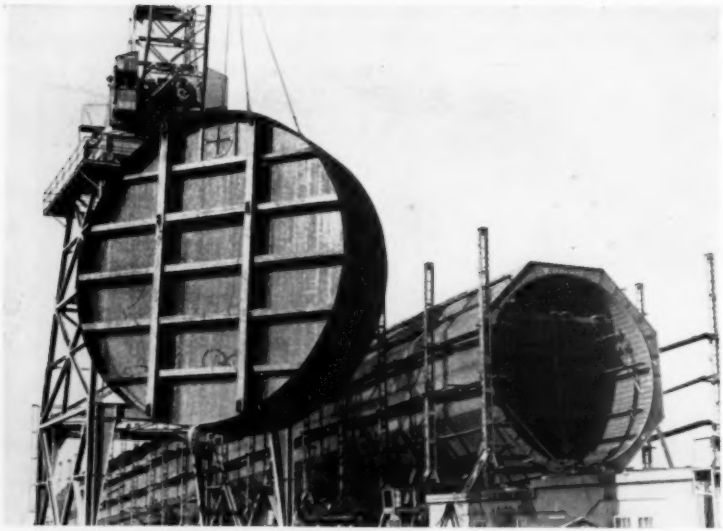


FIGURE 2. Washburn Tunnel tubes fabricated at Pascagoula—the hole that was moved for 500 miles.

FIGURE 3. Four-lane Harvey Tunnel under the Intracoastal Canal; under construction.

triangulated its north shore. With their cooperation this work was completed, and then the network was extended across the lake to the south in the longest known over-water survey.

To make this survey it was necessary to construct four fixed observation towers in the lake because the curvature of the earth made it impossible to see from shore to shore. These towers were located in pairs approximately eight miles from shore and six miles apart laterally. Elaborate platforms, twenty-six feet above water and supported on piles, were constructed to form observation towers. Pile tripods projecting through the platforms, but not connected to them, were installed to form theodolite supports.

All survey work was done at night using directional lights to avoid inaccuracies that result from radiation and temperature changes during the day. When control points on the center line of the bridge were established, its actual length between abutments was fixed at 23.89 miles.

Facts Proved by Tests

There were the usual old settlers' stories about the impossibility of building a bridge across the lake because of the soft mud underlying it and the absence of firm bottom. Others told of the ancient wanderings of the Amite River that had scoured a bottomless bed through and about Lake Pontchartrain.

To find out the facts and to provide a sound basis for design a series of borings at quarter-mile intervals was taken to a depth of 100 feet. At the location of special structures they were extended to 200 feet. At frequent intervals at each hole, undisturbed samples were taken and subjected to complete laboratory tests.

Generally speaking, results of borings were extremely encouraging. Generally the water depth varied between twelve and sixteen feet, with a layer of very soft clay twenty-five to thirty-five feet deep. Below this for the first seven miles from the south shore was dense sand; for the next thirteen miles firm, tough clay with excellent characteristics and high supporting power, and for the northernmost four miles, again dense sand.

As an added precaution against the wandering Amite River, a complete hydrographic survey covering a two-mile-wide strip was

centered on the bridge location, and a quarter-mile grid was run with a fathometer designed to record the top mud line and a secondary hard surface line. So this ghost was laid. There was no ancient channel to make the task impossible.

Pile Test Sustained 420 Tons

One of the difficult decisions an engineer always has to make in a project involving pile foundations is determining the lengths of piles that will be required. Many empirical formulas have been evolved in an attempt to relate the safe bearing capacity of a pile to the number of blows it takes to drive the pile one foot.

Every engineer who has extensive experience on pile foundations comes to realize that these formulas are a snare and delusion. The science of soil mechanics has developed extensively during the last thirty years and provided new tools to work with. We are now able, with some degree of assurance, to translate laboratory results of soils investigations into terms of required pile length. We can increase this assurance and use our soils data with much greater confidence if we verify our conclusions by actually driving a pile and testing it. This was done. There is no real substitute for a test at twelve inches to the foot.

The borings had indicated that pile bents were the answer, but there was great concern over the use of 24-inch square piling because of the lack of lateral stiffness. From the pile capping to the dense sand or the firm clay, the unsupported length would be generally sixty feet, and it was inadvisable to rely on the deep overlaying strata of very soft clay as offering any appreciable lateral support.

A concrete pile company had developed a prestressed hollow piling of 36-inch diameter and on request they prepared to the engineer's design a 54-inch pile ninety-six feet long for test purposes. Special borings made at the exact site of the test provided an accurate record of materials to be encountered.

The pile was driven to absolute refusal and came to rest in a stratum of dense fine sand at a depth of about eighty feet below water level. When loaded with precast concrete discs or "doughnuts," each weighing thirty tons, a continuous record was kept of the settlement. As soon as the pile came to rest another 30-ton

"doughnut" was added and the process of measuring and recording the settlement repeated.

This cycle was continued until the pile sustained a total load of 420 tons. This load was left on the pile for twenty-four hours. The load was then progressively removed and the recovery of the pile measured and recorded as the load was progressively decreased.

The results of this test were astonishing. The maximum settlement recorded under the total load was less than three-eighths of an inch. This is far less than the amount expected to result from the elastic compression of the pile itself under such a loading, and demonstrated that the ultimate bearing capacity of the pile had not yet been reached. No one knows how much the pile would actually carry before it failed because there were no more "doughnuts." Following this test it was determined to use a two-pile bent using the 54-inch prestressed hollow piling.

Deck Design Features Unobstructed Vision

Numerous deck designs were made to establish the greatest possible economy. Various materials were attempted only to find that during the limited time permissible for construction there was not sufficient manufacturing capacity to produce the quantities required. In another instance, 6600-ton fiber tubes were desired for forms, but a new plant would have had to be built for their manufacture.

Finally two designs were selected: one, of welded girders and a concrete deck poured in place with a span of eighty feet; and the second, of a precast prestressed concrete girder and slab fifty-six feet in length and poured monolithically. The design of the prestressed concrete span represents a pioneering engineering accomplishment. The stressing force is applied to the concrete by pretensioning methods which permit the concreting of a group of spans arranged in tandem on the casting beds, but require only a single tensioning operation for the entire group.

The highest specifications of the AASHO were used in design. Particular attention was given to unobstructed observation by motorists. The deadly monotony of thousands of vertical rail supports was avoided by using a high curb and higher concrete rail with smooth-flowing horizontal lines. This design is low but strong

enough to insure safety. It is topped with a four-inch aluminum rail. Vision is unobstructed but this gives a feeling of complete security.

Because it is open season the year round in the South for shooting out bridge lights—that and the problem of birds flying into and destroying them—lighting was not included except at toll booths and the bascules. An innovation expected to be widely adopted was substituted. A patch of scotch light of twenty square inches was secured to the inside web of every other rail bracket on both sides of the bridge, thereby giving almost continuous bands of lights not only to motorists but to shipping as well.

As additional safeguards to navigation, obstruction lights are placed on each side of the structure at one mile intervals and navigational lights at humps and bascules. Fog horns and radio phones will also contribute to safety.

Due to the great repetition possible, the design recognized that the project would be won or lost on shore through cost economies. It obviously was to be a manufacturing job rather than ordinary construction.

All local navigation interests were queried to ascertain their requirements for passage through this obstruction that for the first time would limit their free use of Lake Pontchartrain. It was agreed that at a four-mile point starting at the south shore, there would be first a hump to permit passage of small craft with an opening of 56 feet horizontal and 25 feet vertical; at eight miles a double-leaf bascule bridge with a horizontal opening of 75 feet; at twelve miles a hump; at sixteen miles a second double-leaf bascule, and at twenty miles a third hump.

A novel feature is a turnaround hump at nine miles from the south shore. This permits cars to return to either shore by passing under the hump and without crossing or interfering with other traffic, as shown in Figure 5. Under the hump will be a gas and emergency station. It is believed that many tourists visiting New Orleans will want to drive on the longest bridge in the world to a point where they are out of sight of land but will not want to drive the entire forty-eight miles; hence this feature, in addition to offering service, is a business promoter.

Bids were called for on both steel and concrete designs, and when opened, proved that on a project of this kind steel was no longer a

FIGURE 4. Economical and effective night lighting by use of scotch light.

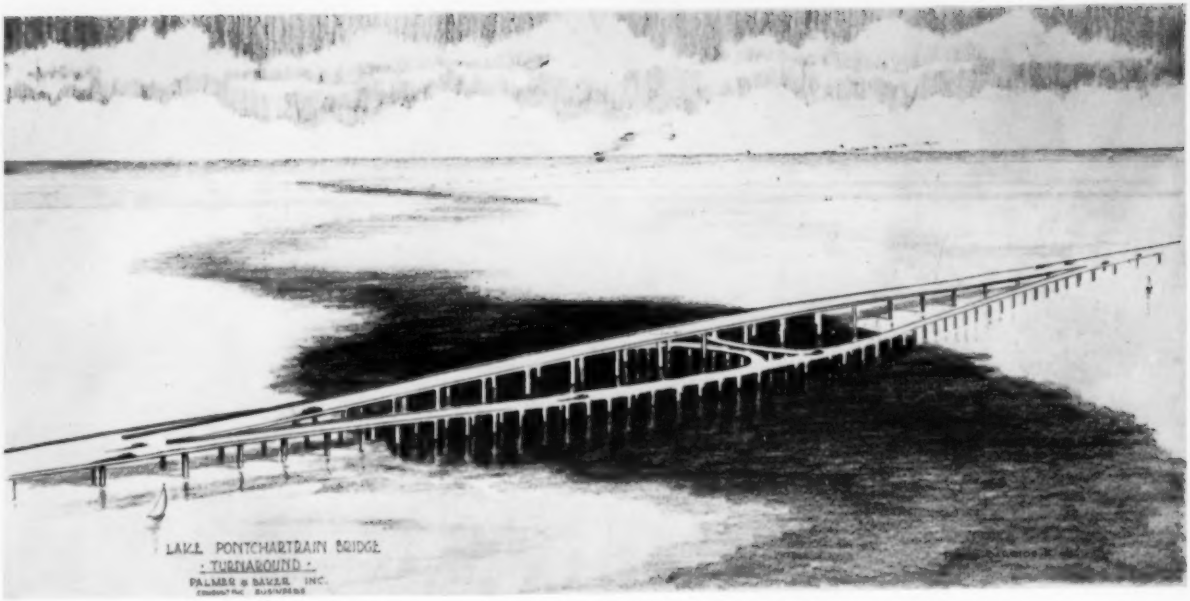


FIGURE 5. Turnaround hump permits cars to return to either shore without crossing other traffic.

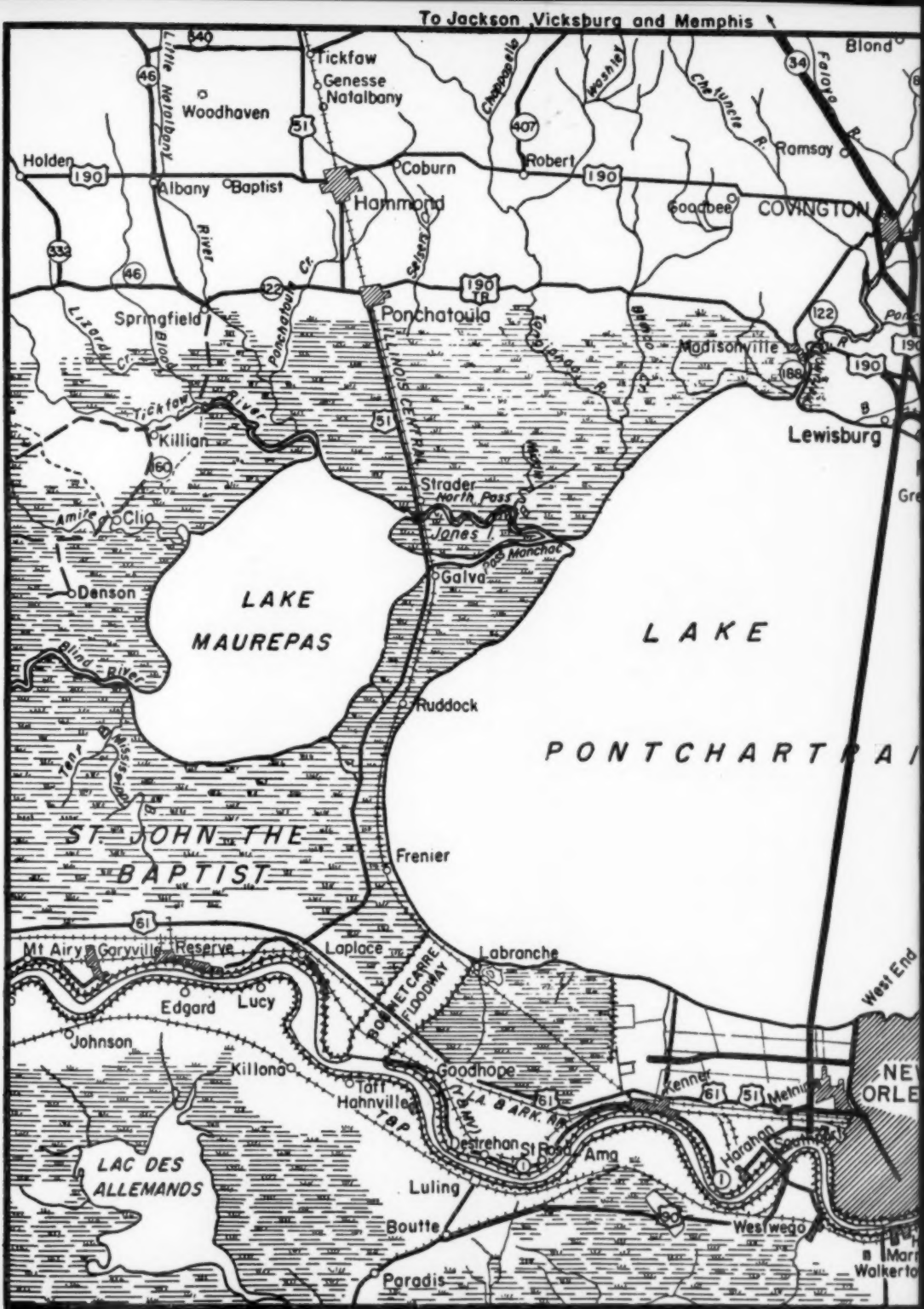
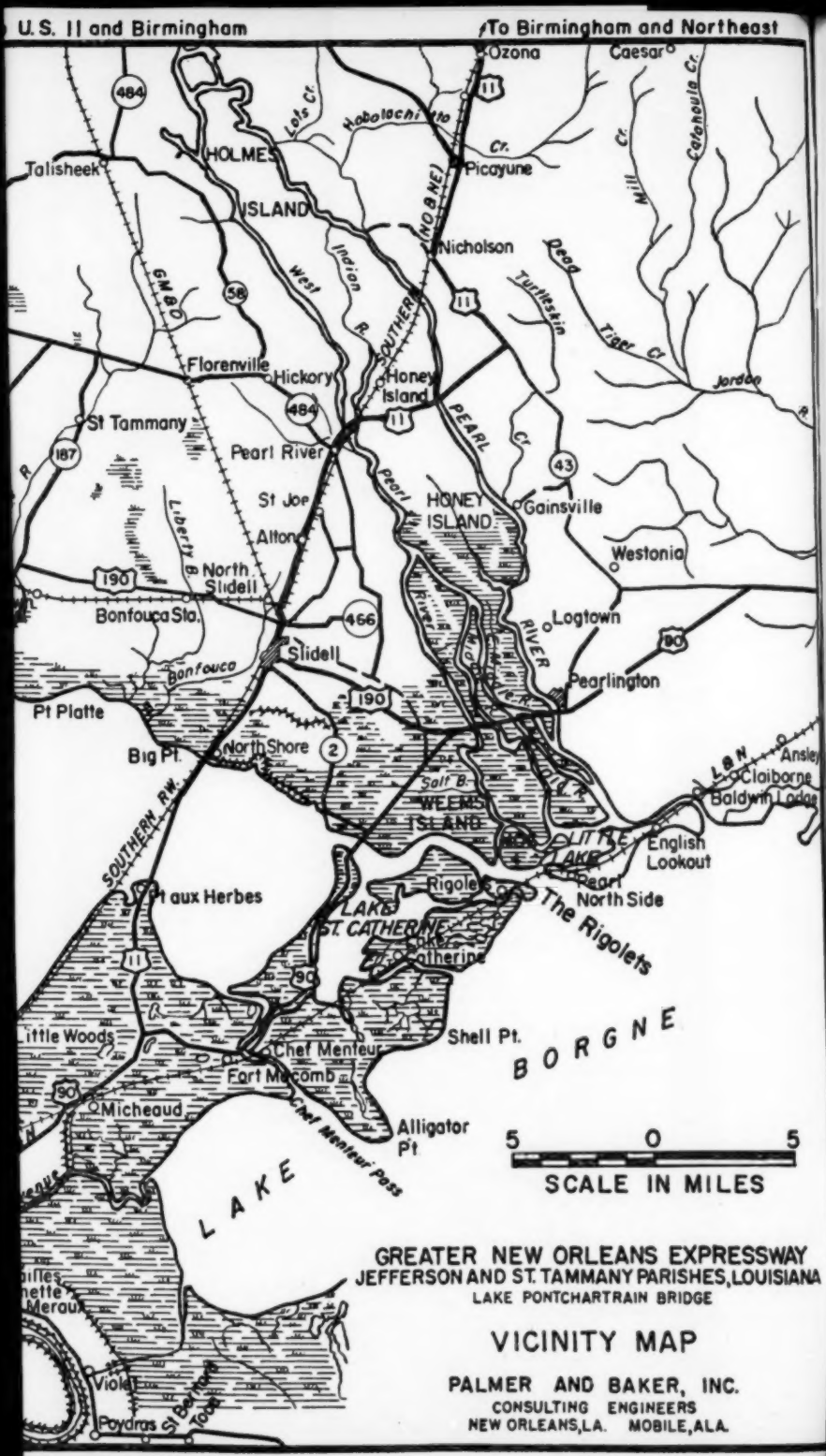


FIGURE 6. Route map of Greater New Or

FIGURE 6. Route map of Greater New Orleans Expressway

essway and Lake Pontchartrain Bridge.



ntchartrain Bridge.

serious competitor. The lowest bidder was a bridge company owned jointly by Texas and Louisiana firms. Their bid of $27,600,000 included all work and equipment from toll plaza to toll plaza, and figured at the extraordinarily low price of $217.80 per lineal foot of roadway.

Time and Cost of Construction

On a toll project, the time of construction is measured in money. Interest during construction on a large project can pile up at an alarming rate; so to combat this devouring factor a completion date of 700 days was established—to the consternation of the general public and some of the potential bidders.

However, those who had studied the job and envisioned the mass production methods possible were convinced that this interval was adequate and that the time-saving over the use of conventional construction methods would net a saving of as much as two and three-quarter million dollars.

Before any construction was started in the Lake the contractor completed a four and one-half million dollar plant ashore, especially designed to expedite this particular project. It has proved itself a model of efficiency and explains the completion of the bridge four months before contract date.

The last of 4,558 piles was driven, almost to the day, one year after driving started. A total of 77.3 miles of piling was cast in this yard, along with 2,279 slabs and pile caps. A goal of 3,000 feet of completed bridge a week was set by the contractor and maintained by him in an excellent performance of co-ordination between shore and floating plant. All this was accomplished despite the treacherous waters of Lake Pontchartrain that offered many anxious times for the fifty-five pieces of floating equipment required.

The struggle between rising costs and limited resources will continue. To be sure, the recent Fallon-Gore Highway Bill offers much to the South as it does to the rest of the country. But in the South so much is needed that the effort to stretch the transportation dollar cannot be relaxed.

Freeways and the Suburbs

ROBERT G. HENNES

Mr. Hennes is Professor of Civil Engineering, in charge of transportation engineering and earthwork engineering, at the University of Washington in Seattle where he has taught since 1934. He was a member of the first and second International Conference on Soil Mechanics and inaugurated the work in soil mechanics at the University of Washington. He is chairman of the Washington State Council for Highway Research, a member of the American Society of Civil Engineers, the American Railway Engineering Association, the American Society for Engineering Education, and an Associate of the Highway Research Board.

THE increased value of real property which accompanies the improvement of access through highway construction is often so conspicuous as to attract the attention of public officials and others interested in the problem of highway finance. Especially notable is the rise in land values when a hitherto undeveloped area is brought within reasonable travel time of a metropolitan center by a new freeway or urban expressway facility.

Among the several factors which influence this readjustment of land values, one of the most important is the increasing rate of migration to the suburbs and the resultant demand for homesites which avoid urban congestion but retain many advantages associated with urban location. This trend is strikingly illustrated by the distribution of the population increase in the United States during the five years from 1950 to 1955. During that period the population of the country increased by 11.8 million persons.

Rural areas actually experienced a decline of 0.6 million persons, while the central cities within the 168 standard metropolitan areas increased by only 1.9 million persons. The bulk of the new population, 9.6 million, settled in the suburbs of our urban centers, and in these five years, suburban areas had a 28 percent increase in population. During the preceding ten years (1940-1950) the corresponding rate of increase was 27 percent. In other words, the rate of suburban growth is spiraling.

Any rapid expansion such as that experienced by American

suburbs in recent years grossly overloads all facilities provided through community effort: schools, utilities, fire and police protection, and, of course, roads. The suburban road problem is unique in that anything done to improve communication between the urban fringe and the urban center encourages further suburban development. Well-designed freeways sometimes are overloaded soon after they are built.

Nevertheless, any progress is accompanied by problems, and despite the difficulties it entails, the flight to the suburbs should be viewed as progress because of various sociological and economic considerations. The most pressing reason for encouraging suburban migration, however, is that we live under threat of attack with nuclear weapons. It is doubtful that any other civil defense measure could be as equally practicable and effective as encouraging the present popular inclination to migrate to the suburbs.

The concern of public officials with the problem of financing urban expressways probably is a proper response to the pressure of popular opinion; but a deeper sense of responsibility would also seek to finance and build expressways as a means of stimulating the dispersal of urban population.

The Allocation of Freeway Costs

Paying for urban expressways is only one aspect of the general problem of highway financing, but it is specially important because of the high cost of such facilities and because of its deviation from the older pattern of road expenditures for which our existing sources of highway revenue were developed.

That the demands of modern urban traffic have evolved a wholly new type of thoroughfare is illustrated not only by the variety of names bestowed upon this new facility—freeway, expressway, superhighway, arterial—but also by the variety of expedients that have been tried out in paying the very high costs.

Two characteristics are common to all the new expressways:

1. They develop only in the concentrated traffic of large metropolitan areas.

2. They are designed for through-traffic, to the elimination of local land access and to the exclusion of local traffic.

These new developments are not minor appendages to the highway system. The Clay Report's ten-year $101 billion road program includes $36 billion for city street construction compared with $46 billion for rural state highway construction. Of course, not all the $36 billion earmarked for streets would be spent on expressways, but the major urban needs fall within that classification. Before very many years, the trend toward suburban living may lift the expressway budget above the level of rural state highway expenditures. It is high time that the public decided how to pay for these expensive new facilities.

The great expense of urban expressways and the extent to which these expenses reflect the cost of providing routes through cities for city traffic is illustrated by the case of the proposed Tacoma-Everett freeway. Exclusive of financing charges and interest, this 65.2-mile project was estimated to cost $194,000,000. Except for 14.4 miles through Seattle the road will be a four-lane divided highway.

If it were not for local traffic, the highway department's Class I, and perhaps even Class II, highway at $335,340 or $207,580 per mile would meet the requirements of the situation. The difference between 65.2 miles at $335,340 or $22,000,000, and the corresponding $158,000,000 construction cost of the freeway provides a measure of the urban influence on transportation costs.

Spreading the extra cost over the entire length of the toll road, the increase is sevenfold; or assigning the increase to Seattle mileage only, the cost per mile is twenty-nine times as high. Neither basis for comparison is above criticism, but either one will serve to illustrate the point.

Our traditional concept of the proper sharing of responsibility for total road and street costs would charge costs against those who benefit by the facility. Thus it has been rather generally accepted that the owners of abutting property should pay all or most of the cost of residential city streets, and highway users should pay all or most of the cost of rural state highways.

In the case of urban expressways, most of the cost is incurred to provide facilities for local or suburban traffic, and the limited access character of the road confers increments of value not on the abutting property but upon the suburban areas contiguous to the

points of access. The tax structure which fits the city street and the rural highway requires modification to meet adequately this new situation.

Even if one rejects on theoretical grounds the prevalent tendency to relate highway taxes with benefits, as some do, it is expedient to adopt a policy which would charge part of the cost of road improvement against the very groups who press for these expenditures, because they personally stand to gain from construction of the new facility. A contrary policy subjects highway administration to the attack of organized groups advocating specific decisions on road location or standards of construction without the check of any personal responsibility for meeting the costs of their proposals.

But even without the special need for a review of highway tax support which stems from the growing importance of freeways, a study of highway finance is amply justified at this time because of the urgency of the national highway problem. The need for augmented road and street construction programs is well known, but it may be timely to note that recent federal road legislation, emphasizing the interstate system, makes no provision for about one-fourth of the $101 billion program. The gap is mainly at the local road and street level. As people become accustomed to the superhighways to be built in the next few years they will become more dissatisfied with inadequate local roads and streets.

The State of Washington Study

In its various aspects the problem of highway finance that confronts the nation as a whole is the prototype for the problem in the State of Washington. In both cases freeway finance is an acute phase of a more general situation. Foreseeing new needs for highway revenue, the Washington State Legislature in 1953, and again in 1955, authorized an interim legislative committee to study "motor vehicle taxation, including the assignment of total highway costs among property owners, general taxpayers and highway users."

In its consideration of the prospectus, procedure, research agency and final report for this project, the legislature's committee was advised by the Washington State Council for Highway Research, a group representative of public and private interests in highway

transportation, serving by appointment of the governor. The research was reported in nine small volumes under the general title of *Allocation of Road and Street Costs,* with the following subheadings:

Part I. An Equitable Solution to the Problem

Part II. Classification, Traffic Volumes, and Annual Costs of County Roads and City Streets

Part III. Bases for Weight-Distance Taxation
Vol. 1. Automobiles and Taxicabs
Vol. 2. Trucks and Buses

Part IV. The Benefits of Rural Roads to Rural Property. Experimental relationships between rural roads and location utility in three Washington counties with reference to the location of agriculture and rural non-farm residences, together with comments on aspects of road finances and tax assessment problems.

Part V. The Effect of Freeway Access upon Suburban Real Property Values. A case study of the Seattle, Washington area.

Part VI. Commercial Motor Carriers as Highway Users in Washington

Vol. 1. Competitive and Structural Analysis of Commercial Highway User Industry in Washington

Vol. 2. The Volume and Character of Freight Traffic Movements by Commercial Motor Carriers in Washington

Vol. 3. Factors Relating to Earning Values of Commercial Motor Carriers in Washington

Part II is based upon research conducted at the State College of Washington. The other volumes represent work done at the University of Washington.

Part V reports a study made to determine the effect on real property values resulting from the relocation of US 10 through an

area east of Seattle which had previously been relatively inaccessible from the city center.[1] The following two sections are abstracted from this study:

Suburban Seattle and US 10

Seattle occupies an isthmus between Puget Sound and Lake Washington. Mercer Island is in Lake Washington on the direct highway connection between Seattle and the east. For many years Mercer Island has been connected with the east shore of Lake Washington by a bridge, but until 1940 ferries provided the only direct connection between the Island and Seattle to the west. To reach Mercer Island by land from Seattle it was necessary to drive around either the north or the south end of Lake Washington, a trip taking approximately three-quarters of an hour.

The construction of the Floating Bridge in 1940 reduced the travel time from downtown Seattle by two thirds; from approximately forty-five minutes to fifteen minutes. With such a drastic improvement in access it could be expected that Mercer Island's development and settlement would be accelerated, and that values of Mercer Island real estate would advance—probably more than in most other sections of the Seattle metropolitan area. Relatively similar benefits also could be anticipated for the mainland area immediately east of Mercer Island through which the freeway extension of the Floating Bridge passed.

The selection of Mercer Island and the larger area to the east (East of Lake) for study was dictated not only by the convenience of their location, but also by the singular fact that these are the only suburban areas in the State of Washington which have experienced improved access through freeway construction over a relatively long time. The span of fifteen years since the construction of the Floating Bridge covers sufficient time to yield a useful model of the effect of improved access upon property values.

The study recognizes three significant time periods: The pre-bridge period from 1935 to 1940; the interim or toll-charge period from 1940 to 1949, and the toll-free interval since 1949. In the

[1] This investigation was carried out by E. P. Winter and assistants under the direction of Dr. Bayard O. Wheeler, Professor of General Business, University of Washington.

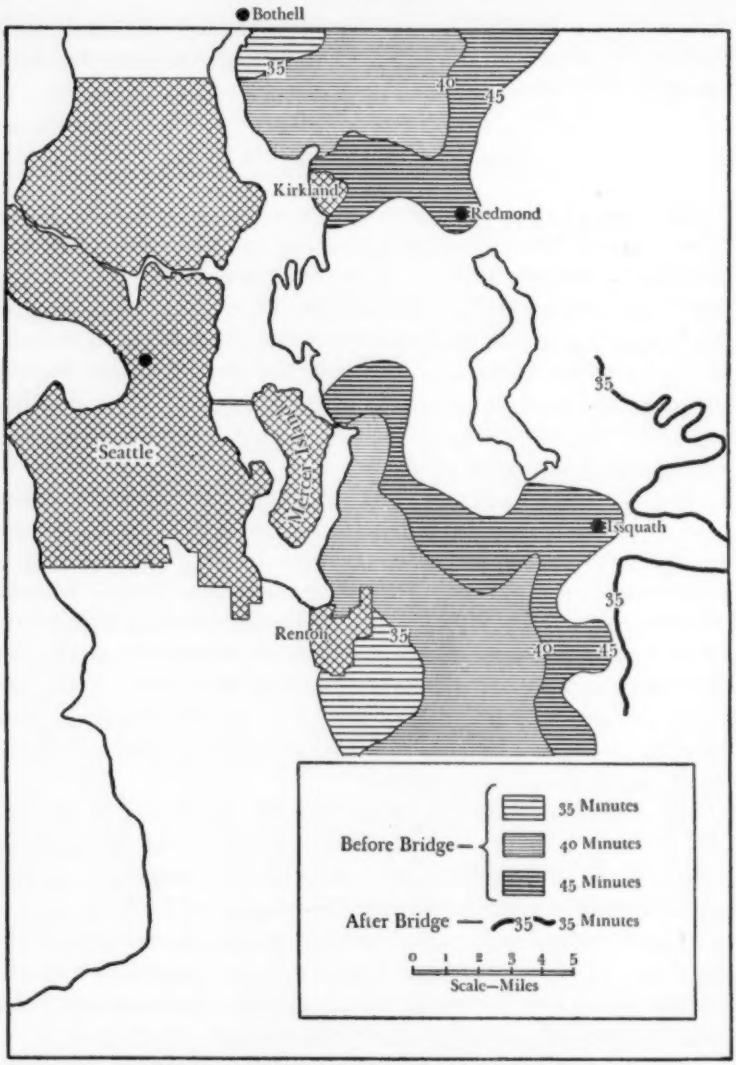


FIGURE 1. Driving time from Seattle City Center.

Mercer Island study, value data were collected for these three periods, but the findings for the toll-charge period did not contribute sufficiently to the objectives of the study to warrant their use. Similar

information was not collected for the subsequent study of the suburban area lying east of Lake Washington and Mercer Island.

To measure the change in property values, records of actual sales were compiled for both the before-bridge and after-bridge periods. The type of real property covered in the study is improved residential and unimproved land suitable for residential development, whether platted or unplatted. Agricultural, commercial, and other types of land use are excluded.

The long time covered by the study required the selection of a type of property that predominated throughout the entire time period. The strictly suburban, even semi-rural, character of the survey areas prior to 1940 precludes consideration of commercial and industrial properties as reliable sources of information on changes in land value representative of the survey areas.

The unique objective of the study required a depth of coverage and analysis not common to other studies. The isolation and measurement of access influence alone, among the many variables affecting property values, dictated the careful identification and evaluation of other influences so far as possible. Topography, community facilities, changing local road patterns, inflationary effects and other factors were recognized as contributing to property values.

The Mercer Island pilot study revealed that some of these factors are not measurable within a range of acceptable reliability, except at great cost. In the survey area East of Lake, as well as Mercer Island, those variables were considered which appeared to be dominant in affecting property values; location on waterfront or inland, degree of capital investment shown by improvement or nonimprovement, and the level of economic activity in the Seattle urban area.

Some of the new or unusual problems encountered at the outset were the insular nature of Mercer Island and its topographical affinity for waterfront development; the multiple-access approaches to the survey areas from Seattle both north and south of Lake Washington, before and after construction of the bridge; and most difficult of all, the collection of reliable value data for a twenty-year period spanning deep depression with limited real estate activity, and high level prosperity with unprecedented growth in the area.

Of the several available sources of property value data, the best was the record of sales transactions in the office of the county auditor.

Only those sales were listed which buyers chose to have recorded, but unrecorded sales are estimated to constitute only a small fraction of the total. Since title insurance companies classify these public records by location of property, this source was used with favorable results in coverage, time and expense.

The sales data were sampled by a pre-determined sample pattern designed to yield property value information for selected categories of property at different periods of time. Resales of the same property in both pre-bridge and post-bridge years were infrequent.

Economic and other conditions were dissimilar in the two time periods. Market activity in real estate and suburban development was slow in the pre-bridge period, while activity in the post-bridge years assumed boom proportions. Moreover, land availability, building methods, and consumer preferences have all undergone change in the interim. Accounting for all such divergences would be difficult, if not impossible. Expressing values in constant dollars at least corrects the data for one of the most important differences between the two periods.

Few previous studies have attempted to isolate the influence of access from the other factors affecting property value. When undertaken, it has been through the use of comparable control areas. While this method commends itself, and was used in this study, a more precise measure is desirable in seeking results which may be useful in the allocation of highway cost responsibility.

Multiple regression analysis offers the possibility of achieving greater precision in isolating the value of access. Both of these methods were used in this study, and their use is discussed in the following paragraphs.

Survey and Control Areas

For all metropolitan areas reported by the United States Census in 1950, population increases since 1940 amounted to 13.9 percent inside the central city and 35.5 percent outside the central city. Comparable figures for Seattle are 46.5 percent and 27.0 percent, respectively. It is necessary, however, that the suburban study areas be compared not only with the city as a whole but, more pertinently, with other suburban areas of similar characteristics, not experiencing access

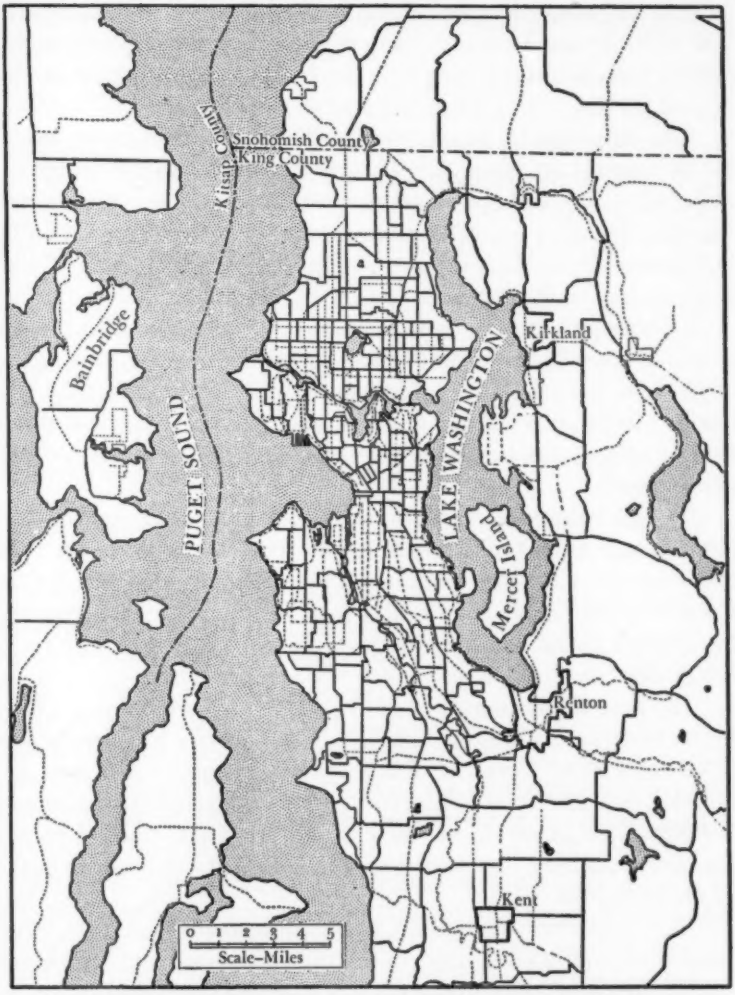


FIGURE 2. 1950 Census tracts, Seattle, Washington and environs.

betterment since 1940. With this in mind, the Mercer Island survey area was compared with Bainbridge Island as a control area; and the East of Lake survey area was compared with the Southwest Snohomish County control area.

Mercer Island is an area of four thousand acres located in souther-

ly Lake Washington, approximately one mile east of Seattle. The island divides itself naturally into three main areas: a gently rolling plateau with occasional steep hillsides in the north; a rugged narrow central portion, and a larger flat area to the south.

The development of the area has been impeded to some extent by an inadequate water supply, and by the handicap which the impervious clay soils place on septic tank operation. The rugged shoreline provides beautiful estate settings, but difficult road-building terrain. State Highway 2, an extension of the Floating Bridge freeway, crosses the northern end of the island.

Bainbridge Island lies west of Seattle in Puget Sound. It is topographically similar to Mercer Island, but is three and a half times as large. Like Mercer Island, the water supply is limited. Like pre-bridge Mercer, it is reached from Seattle by ferryboat. About three-fourths of the area is suitable for agricultural use and residential development.

In 1940 Bainbridge had a population density of 125 persons per gross square mile, compared with 187 for Mercer. Between 1940 and 1950 the growth in population amounted to 34.5 percent for Bainbridge, 232.6 percent for Mercer Island. Both islands were forty-five to sixty minutes travel time from downtown Seattle in the pre-bridge era.

The East of Lake survey area includes 128 square miles in a tract twelve miles eastward from Lake Washington. State Highway 2 provides expressway service to the west over Mercer Island and the Floating Bridge to Seattle. The entire area was accessible from Seattle in the pre-bridge period by roads around the Lake, but the bridge has made possible a time saving of from five to thirty minutes in the trip from Seattle.

The Southwest Snohomish County control area comprises forty-three square miles lying north of Seattle, and is similar to the East of Lake survey area. In 1940 this control area had a population density of 140 persons per gross square mile, which had increased 124 percent by 1950. The entire East of Lake survey area experienced a 109 percent population increase in the same decade, from its 1940 population density of 283 persons per gross square mile. But the more comparable fifteen to twenty minute time-saving zone, East of Lake, had a more significant population increase of 141 percent. Both the

survey area and the control area were thirty to fifty-five minutes from downtown Seattle in the pre-bridge era.

TABLE I.

Land Values in Constant (Deflated) Dollars

	Pre-Bridge Values		*Post-Bridge Values*		*Percent Increase*	
	Mercer	Bainbridge	Mercer	Bainbridge	Mercer	Bainbridge
Waterfront ($/front foot)	$50.11	$24.98	$137.82	$43.94	132	76
Inland ($/square foot)	0.103	0.058	0.319	0.088	210	58
	E of L	Snohomish	E of L	Snohomish	E	S
Waterfront ($/front foot)	$43.91	$51.37	$139.37	$110.13	217	114
Inland ($/square foot)	0.049	0.063	0.241	0.225	392	257

Isolation of Access Influence

The preceding paragraphs exemplify a method of distinguishing the effect of access on land values through comparison of sales prices in two areas which are considered to be comparable in all significant respects except the quality of access.

As an alternative procedure, one might find the effect of improved access in a single area by the mathematical elimination of all other variables affecting value. Multiple regression seeks to identify the influence of access alone among the many causal factors influencing real estate value.

To begin with, an equation is formulated which expresses the best judgment regarding the linear relation between dependent and independent variables. Multiple correlation measures the extent to which this linear relation is justified, and establishes the best values for the coefficients in the equation.

In the regression analysis made for the East of Lake survey area, the following formula was constructed:

$$Y = b_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5$$

where $Y = \log_{10} 1000V$, and V is the average adjusted unit sales value; $b_1, b_2 \ldots . b_5$ are the regression coefficients: and the X-terms segregate

sales made before and after bridge construction, improved and unimproved property, and the location of the property according to time-saving zones.

Each of the six variables involved in the equation was measured 1717 times in the development of the solution. The multiple correlation between Y and $X_{1 \ldots 5}$ was found to be 0.34; significantly different from zero, and showing a positive correlation, although notably less than a perfect correlation of 1.0. Holding the other variables constant, it was found that the construction of the bridge was responsible for a 69.8 percent increase in the average value of land, with a computed standard error of 29.1 percent.

Finally, it is now possible to tabulate the study findings according to the analytical procedures employed.

TABLE II.

Percentage Increase in Adjusted Land Values Attributed to Access

Method	*East of Lake*	*Mercer Island*
Regression	70%	
Comparative[1]	72%	159%
Comparative[2]	117%	129%

Estimation of Relative Benefit

The use of the results obtained from Professor Wheeler's research poses another problem for the highway economist. Obviously the dollar value of road betterments will vary with the location of the road and with the degree of land development prior to improvement of access. The relationship between highway-user and property-owner benefits should be more nearly constant, especially on those highways where the bulk of the traffic is city suburb to city center movement.

This is true because user and property benefits have a common basis. Road improvements raise the value of real property because highway users can then reach the affected property with greater convenience and at less expense. Conversely, most road usage is merely a means to the end of reaching some specific parcel of land.

[1] Comparison of survey and control area dollar increases, expressed as percentages of pre-bridge values.

[2] Excess of survey area value increase over control area increase, in percent.

While this merging of benefits encourages some faith in a degree of uniformity between user and property benefits in reasonably comparable projects, it should not argue against the usefulness of making a distinction between the two beneficiaries. Despite the fact that highway benefits are broadly diffused throughout society, and are inter-related, they are not uniformly distributed with respect to individual persons. People differ greatly in their ownership of land and in their use of highway transport.

Complete reliance on property taxes would give some highway users a free ride; and a complete reliance on user fees for the support of highway improvement would confer on some landowners an unearned increment of land value. More importantly, the pressure for local improvement is apt to be exerted most strongly by those who expect to profit directly from the proposed work. Better public policy decisions are encouraged when those who benefit personally from the proposed expenditures know that they will be charged for part of the expense.

An estimate of relative benefits can be reached by considering a typical individual dwelling. A study of property assessments in the State of Washington, made in 1953, found that the average value of single-family residences in suburban Seattle east of Lake Washington was $13,260. If this valuation included a 70 percent increment due to improved access, as suggested by Professor Wheeler's findings tabulated above, the total highway benefit to the average residence would be $7,741. At 3 percent interest, this would correspond to an annual benefit of $232.

The average daily traffic over the Lake Washington bridge in 1953 was 24,760 vehicles. At least 20,000 of these can be considered local, as the 1953 ADT on the same highway at a point just east of the survey area was 4,541 vehicles. The ratio of local to through-traffic might be, roughly, five to one.

As another approximation, we might assume one round trip to Seattle per day for each residence, with a time-saving of forty minutes per round trip, compared with the pre-bridge era. To this should be added the time saved by the through-driver, which, on the five to one ratio suggested above, amounts to an additional eight minutes.

The gross user benefit per residence can now be estimated if an appropriate money value can be assigned to forty-eight minutes of

saved time. The difficulty here is that time has different values for different drivers. The most significant information on this point is that published in Highway Research Board *Bulletin* No. 61, "Effect of Travel Time and Distance on Freeway Usage," by Darel L. Trueblood, which includes data on driver choices between distance saving and time saving for trips on The Shirley Highway in Washington, D. C.

When time savings per trip are priced on the basis of vehicle operating costs for additional trip lengths, it becomes possible to find the value placed on time by the median driver. This value appears to be in the neighborhood of $1.70 per hour. At this rate a 48-minute time saving would be worth $1.36. As the property benefit per residence has been estimated to be $232 per year, or 64 cents per day, a rough division would assign one-third of highway costs against property and two-thirds against the user.

This assignment to property represents approximately the land acquisition cost of the urban expressway type of highway facility. Recognizing on the one hand that truly precise determinations of relative benefits would apply only to the specific project which provided the basic data, and on the other hand, the need for a general rule for application to future project proposals, a practical policy might well charge benefited property with the cost of acquiring right-of-way for those freeways built primarily to connect suburban areas with metropolitan centers. Where this function is served by the urban extension of a state highway it would seem appropriate to apply this rule only to the additional width of right-of-way needed to accommodate traffic in excess of the count on rural sections of the highway under consideration.

There remains a problem of contriving an appropriate method of property taxation. Here a useful precedent is found in the establishment of local improvement districts, but with rates varying with distance from points of freeway access rather than with distance from the freeway itself.

When freeways derive a fair measure of their support from benefited property the present trend toward urban decentralization will be encouraged rather than curtailed, and there will be a natural tendency to promote those freeway projects having an attractive cost-benefit ratio.

The Co-ordination of Highway and Traffic Engineering

JOHN C. KOHL

Mr. Kohl is Professor of Civil Engineering and Director of the Transportation Institute at the University of Michigan where he has been a member of the faculty since 1946. In a consulting capacity he has been associated with, among others, the Automotive Safety Foundation, the American Automobile Association, and George S. Richardson of Pittsburgh on a wide variety of transportation planning, highway and traffic problems. Mr. Kohl is a member of the Department of Economics, Finance and Administration of the Highway Research Board as well as several of its committees, a director of the Educational Division of the American Road Builders Association, and a founder member of the American Society for Traffic and Transportation.

AMONG the 38,000 traffic fatalities in the United States during 1955, the death of a Michigan school teacher in a car-truck collision at an intersection in suburban Detroit is of singular significance to highway administrators and traffic engineers alike. The chain of events following that accident portends a state of frustration all too widely manifest today.

The complex reaction to this traffic tragedy provided front-page news in the Detroit papers for weeks. Almost immediately the usual neighborhood clamor for a traffic signal was aroused, but was supplemented by periodic human blockades of Telegraph Road (US 24) –the major highway on which the accident occurred. Women, presumably mothers, actually lay in the roadway and resisted efforts of the police to restore movement of important and vital traffic.

Attempts to reach a solution through normal channels failed. Warrants for traffic signals could not be found, but the traffic engineers' reports would not satisfy the aroused citizens who continued their blockade. Finally, the Governor of Michigan, in a move highly unusual in the highway world, appointed a special committee to study and recommend a compromise for this single intersection

alone. That committee managed to quiet the local area although it has not solved the basic traffic problem.

Here, obviously, is a failure, small in itself but large in its implications. Unless highway officials can cope successfully with such problems, principally by fundamental improvements before such situations develop, they will lose the confidence of the public and ultimately will find their jurisdictions curtailed or unsurped by other agencies of government. The long, slow effort to establish comprehensive highway management will have been frustrated by the omission of one vital element—the effective co-ordination of highway and traffic engineering to secure safe, efficient transportation.

Unlike other systems of transportation, highway transport in the United States is extraordinarily diffuse and almost defies definition as a system. Our 62,000,000 vehicles are built by a few, very large industrial organizations, and are operated by some 76,000,000 individual citizens driving over the 3,333,000 miles of public highways and streets built and maintained by more than 30,000 governmental units.

Regulations for the control of traffic are matters of public law enforced by our police and with matters of violations administered by our courts—truly, a maze of legal confusion. Only our ever-increasing dependence upon highway transportation is forcing a trend toward desirable centralization of authority in the face of typical and tremendous inertia of our political machinery, and even that potential centralization is still confined largely to the field of highway law.

Role of Traffic Engineering

To achieve more effective public support, highway people must prove that theirs is a genuine concern for the movement of traffic, not for the construction of pavement theaters where mothers' blockades are to be staged. They must prove equal to the task of welding the material and human elements into a highway system adequate to our progressive interest in highway transportation. Essential is their general understanding of the role of traffic engineering and their full employment of the skills and knowledge which that young profession can contribute.

Just what is traffic engineering, and where does it fit? What can it contribute? What must be done to give it proper recognition?

There is no better start to the answering of these questions than a look at some definitions. As promulgated by the Institute of Traffic Engineers: "Traffic engineering is that phase of engineering which deals with the planning and geometric design of streets, highways, and abutting lands, and with traffic operation thereon, as their use is related to the safe, convenient and economic transportation of persons and goods."

Or in simple language, traffic engineering puts the human factor in the highway equation.

Contrast this broad concept with the definition appearing in a current textbook of highway engineering[1]: "Traffic engineering deals with the direction and control of vehicular and pedestrian traffic on existing highways and streets."

This, unfortunately, is an all-too-common view which is far too narrow because it deals only with facilities already built. Many of our highway troubles would be avoided if planning and design were predicated on a knowledge of traffic principles.

It is encouraging to note, however, that Oglesby a little later in his chapter does admit: "Sometimes traffic engineering functions are expanded to deal with problems of geometric design and highway planning." Until *sometimes* can become *always,* we shall be on uncertain ground. We shall continue to have more, many more, highways like Telegraph Road—initially good, soon obsolete, and not to be superseded by any new and adequate facility for a long time.

Without comprehensive knowledge of travel patterns, the highway engineer can only by sheer chance meet the traffic need and escape from creating more problems than he solves. Even more serious are the doubts created by his mistakes in the minds of the very people he is trying to serve.

Planning and location are two distinct steps which should not be confused. True, getting the line of a new highway on the ground is a necessary function, but equally important is an intelligent decision on the need for the particular highway to be built, its character and its relationship to the area through which it is proposed. Only

[1] *Highway Engineering:* Laurence I. Hewes and Clarkson H. Oglesby; John Wiley and Sons, Inc., New York, 1954.

with such factors positively resolved through planning should location come into the picture with its entirely different criteria and techniques.

In highway planning the traffic expert brings the human factors into major account; in locating, the field engineer brings terrain, soils, grading, and other physical factors to bear. Both are essential to successful highway development.

In other areas of highway activity, also, the traffic engineering approach is indispensable. Programming, through scientific determination of priorities and examination of the effect of construction of any links on the total transportation pattern, requires the traffic touch. All too many projects have been built without any basic thought given to their fitting into an overall plan; some have produced few real benefits, if not actual detriments.

Data on vehicle operation and highway use, as provided by the traffic engineer, make possible rational analysis of the complex questions of transportation costs and highway economics. In many ways can this uninhibited profession contribute to our knowledge of highway finance—the very heat of the problem of an expanding highway program.

Many Factors Build Traffic Safety

Traffic safety, as built into the highway, cannot be accomplished without correct geometric design and intelligible operational controls—signs, signals and markings which are the traditional, and by no means the only tools of the traffic engineer. It is his province to establish working knowledge of driver-behavior in the total highway environment: here there certainly must be harmony if there is to be a minimum of accident experience, and a maximum of highway service.

There is scarcely an aspect of highway activity in which some traffic consideration does not enter. Even structural design of culverts or sub-bases requires a knowledge of both the magnitude and frequency of loads imposed by traffic. Quite properly many rules-of-thumb can be applied to avoid extensive investigations for every situation, but somewhere very early in design stages the traffic classification of the road in question should be established.

Yet, obvious as its fundamental importance to highway management should be, too much evidence at hand indicates extraordinary failures to recognize and apply principles derived from traffic engineering knowledge.

As a simple instance, it may be observed almost everywhere on our roads that traffic signs are misused so much that their utility is seriously impaired and some actually constitute a menace rather than an aid to traffic. Clusters of route markers and directional arrows which no driver has time to decipher; 65 mph. speed limits on 25 mph. turns, and 20 mph. limits on 50 mph. roadways, do not invite respect of drivers and may be directions to disaster instead of signs of life as intended.

An item in a recent press association dispatch printed in newspapers throughout the country was head-lined "Dead-End in Cornfield" and stated that a new five-mile pavement ends in the middle of a cornfield because a state highway department "changed its mind." A recital of errors, omissions, bad designs, and faulty planning could fill more than a large book, and still be only the beginning.

It is fair to ask, "How can this be?" Answers are not difficult to find when one considers both the newness of traffic engineering and the educational background of our highway personnel. Most of them just have not been indoctrinated with the fundamentals of traffic. They tend to ignore what they do not understand, and thus unwittingly erect frustrating barriers which so often block the traffic engineer from an effective role.

Increased Highway System Needs More TE

Traffic engineering as a profession is not yet a generation old, and numbers actually only a handful of trained men—far too few to go around. Through gradual expansion of traffic engineering education, as qualified instructors and facilities can be developed, the supply of specialists can be brought into some balance with demand. Sound training and education in a field so extensive and complex cannot be done overnight, so gains of newly trained men will lag for some time to come.

Almost immediately, however, we are facing certain expansion

of highway activity—an expansion of unprecedented proportions. If unprecedented mistakes in highway planning, geometric design, and operating controls are to be avoided, then somehow a greater awareness of traffic demands and requirements must be achieved within existing organizations.

First of all, our present traffic engineers, even though they may be in low spirit, can resort to some good, old-fashioned evangelism directed toward their superiors in management. Thereby, those responsible for administering this expanded highway program, can be made aware of the crying need for comprehensive design; they can be encouraged to seek a good balance between traffic and highway engineering on all work and to seek the advice of consultants when their own staff is inadequate to solve special problems.

Next, those attempting the education of civil engineers can see to it that all who are heading for highway jobs have at least an introduction to traffic engineering principles in their undergraduate programs. This will not be easy because pressures are already great to curtail engineering courses to permit more science and a dose of the humanities.

At the University of Michigan this very year, there just isn't enough time on the calendar in our elementary highway course to include the traffic engineering chapter in the textbook. Fortunately, we can catch most of the students in one of our full-fledged traffic courses, though some escape us altogether. Here, traffic engineers and enlightened highway administrators can support the professors' efforts to expose every civil engineering student to the fundamentals of traffic.

As another step in the right direction, in-service training programs can acquaint practicing highway engineers with some of the elements of traffic design, sources and interpretations of traffic data, and equip them with the minimum tools to solve the ordinary problems.

A word of caution is necessary, for successful courses require careful planning, excellent instructors, and must receive top-level support. Where these elements can be developed, present personnel can be up-graded quickly to meet some of the increasing demands for traffic knowledge.

Finally, research in traffic must be greatly expanded. Not only

would more be learned about traffic fundamentals and their use, but also this very activity in universities and highway departments would stimulate a greater appreciation and attract more of the better students to the field.

Lest anyone feel that traffic engineers know all the answers and have merely been pleading for recognition, it should be necessary only to point to the rapid changes in vehicle design and the staggering increases in auto registration as posing new problems. More powerful and responsive cars, bigger and heavier trucks—more of everything including long mileage of expressways—create new traffic conditions which must be explored.

Research Needed in Allied Fields

Knowledge of driver-behavior is admittedly scant and incomplete because we are only now discovering the research resources of many areas hitherto disinterested in the field of traffic. Psychologists have already contributed to our stock of facts, but few of them have worked closely with engineers to establish any broad understanding of environmental influences upon driver-behavior. Now there seems to be opportunity for the first time to bring into traffic research efforts not only more psychologists, but also mental health experts, neuro-psychiatrists, and other specialists previously foreign to this exciting and vital study.

Much more needs to be known about trip motivation, travel patterns, traffic generation in relation to land use, growth and decay of traffic and a host of other things significant to planning. Maybe a costly error is being made in considering expressways as the ultimate in highway progress. Instead, research might find them to be vestigial remnants of railroad engineering not at all suited in the long run to the inherent character of highway transport.

A great deal more can be learned about vehicle-design features as they affect safety. The crash-injury studies of today consider the accident inevitable and look to "packaging the passenger" as the answer. Perhaps that is the only feasible concept, but we would like to find out what further advances can be made in accident prevention before we bow to the inevitable. Let's not admit failure before we've really tried traffic engineering research.

Despite these admitted areas of ignorance we have sufficient skills today to do a much better job of highway management if we can only arrange to use them. We must co-ordinate and integrate traffic and highway engineering more effectively than ever before if we are to maintain our motor age.

With imagination, co-operation, and leadership throughout the highway fraternity we can surmount the problems ahead, establish a truly modern era of land transportation, and replace feelings of frustration with the satisfaction of solid professional achievement.

Highway Programming in New Orleans Metropolitan Area

GRADY CARLISLE

Mr. Carlisle is Assistant to the Director of the Louisiana Department of Highways. Previously, he was Assistant Traffic and Planning Engineer in the Department. He has been employed in the Traffic and Planning Section since 1936, except for two and one-half years' service during World War II. Mr. Carlisle is widely experienced in all phases of highway planning and traffic engineering. In 1953-54 he was staff engineer for the Department in the preparation of a long range highway needs study under the guidance of the Automotive Safety Foundation. He acted as a consultant to the Legislative Committee that prepared the legislation for setting up the mechanics and financing the long range Highway Improvement Program for the State of Louisiana.

THE CITY of New Orleans, Louisiana, is situated about eighty miles upstream from the Gulf of Mexico on a narrow strip of delta land between the Mississippi River and Lake Pontchartrain. The population of the city proper was 570,445 persons in 1950, making it the nation's sixteenth largest city and the twenty-second largest metropolitan area. It is one of the world's largest inland seaports and is the nation's number two port in dollar value of cargo handled.

New Orleans was founded in 1718 by the French who developed the high ground near the river in the area known as the Vieux Carré.

American frontiersmen moved into New Orleans after the Louisiana Purchase and competed with the French for occupation of the high areas adjacent to the river. The usable high ground was rapidly inhabited and it became necessary to drain the swampy land for development toward Lake Pontchartrain.

The early settlers did not realize that the wide strips of land on which the canals were dug would some day become important traffic arteries for vehicular traffic. However, as the areas served were drained, many of the canals were filled and became wide boulevards. Only recently one of the large canals was filled and a portion is being used to construct New Orleans' first expressway.

Beyond the ramparts that formed the boundaries of the old city stretched the large wedge-shaped crown grant plantations and estates. The city expanding along and from the bank of the river followed the lines that defined those properties. Thus, the ancient land lines have profoundly influenced the development of the unique street system of the present city.

Those streets that follow the crescent shape of the Mississippi and form a series of concentric arcs are crossed by a group of streets that begin at the river and converge toward a common point that lies about half the distance between the river and Lake Pontchartrain. Appended to this wedge-shaped system are the areas developed later; some with conventional street patterns, others reflecting the personal notions of their developers.

Traversing the whole are several notably wide boulevards, many of which do not fit the desired movement of traffic and owe their present width to the happy accident of long ago having been occupied by canals. Throughout the old city are the narrow and offset streets, the result of the absence of co-ordinated planning.

1944-45 Traffic Survey

Recognizing the acute need for major improvement of the urban highways in New Orleans and that improvement of these deficient sections would be a major postwar objective, the department of highways conducted a traffic survey of the metropolitan area in co-operation with the Public Roads Administration of the Federal Works Agency. The New Orleans metropolitan area included all of Orleans Parish and the adjacent urban areas in Jefferson Parish including Gretna, Westwego, and Marrero.

To determine basic information on the individual trips that make up the total traffic streams, it was necessary to devise some technique in which origin and destination of all trips could be ascertained. Origin and destination surveys previously conducted by the department were made by roadside interviews of drivers. It was obvious that this method of interview was not practicable on all movements within a large metropolitan area.

A new technique was developed by the Public Roads Administration and New Orleans was among the first places to employ the

method. A ten percent sample of all the dwelling units in the metropolitan area was selected and the residents of these units were interviewed; the actual travel performed on the week day preceding the call was obtained from those five years of age or older. The travel data obtained from the sample were expanded to the universe.

External origin and destination stations were conducted on all highways entering the metropolitan area to obtain travel information on non-residents of the area. The origin and destination information was supplemented by ground counts along the streets to determine existing usage and these data provided the basis for developing plans for the major improvement program.

Survey Findings

After the desired path of each trip within the metropolitan area on an average day was determined, the trips were plotted as desire lines to determine visually the future paths of demand by motorists. In this manner alternate systems of freeway routings could be projected on assumed locations that would best serve the traffic requirements, as determined by detailed time-distance analysis based on the origin and destination of each trip found in this study.

Figure 1 shows the major desire lines determined from the 1944-45 survey. To expand the survey data to the design years, the population, vehicle registration and gasoline consumption statistics and projections shown graphically on Figures 2, 3 and 4 were carefully studied.

Arterial Plan for New Orleans

In 1946 the department engaged Robert Moses of New York to prepare a report and recommendations on the development of arterial expressways to relieve traffic congestion in the city. The report, submitted in November of that year, suggested the construction of a "U" shaped expressway around the main business district, extending from the Airline Highway, the main route of business approach to the city, along the right-of-way of the New Basin Canal (Pontchartrain Expressway); thence across a developed area to the river front, along the water front over railway properties

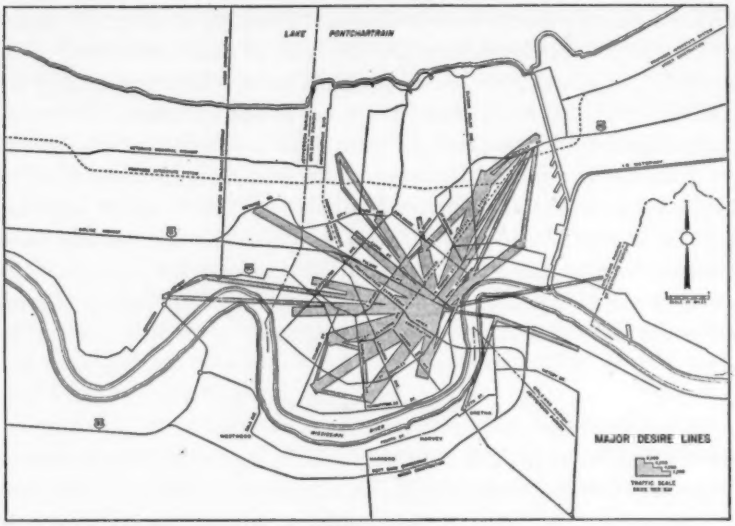


FIGURE 1.

to and along Elysian Field Avenue, to connect with highways from the east on Gentilly Road.

It was recommended that this expressway connect with a proposed new high level Mississippi River Bridge (and highways on the west bank of the river) near the foot of Calliope Street.

The report stressed the importance of adopting the railroad grade crossing elimination and terminal improvement program under consideration at that time. The report stated, "It is not too much to say that if these plans, and particularly those which center in the Union Passenger Terminal, are not carried out in something like their projected form, nine-tenths of the arterial program proposed would have to be abandoned. In fact, so little would remain it could hardly be called a program at all. It would simply consist of odds and ends of neighborhood improvements with little effect upon the city as a whole."

When the traffic survey was conducted in 1944-45, railroad grade crossings over the maze of railroad tracks created a most difficult problem in the movement of vehicular traffic. The many railroad tracks wound their way through the city to one of five scattered passenger stations.

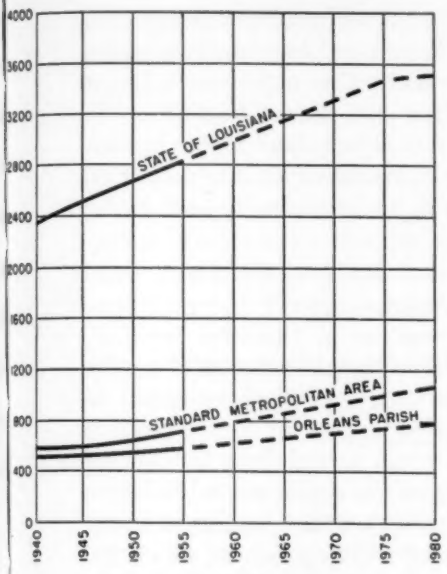


FIGURE 2. Population growths.

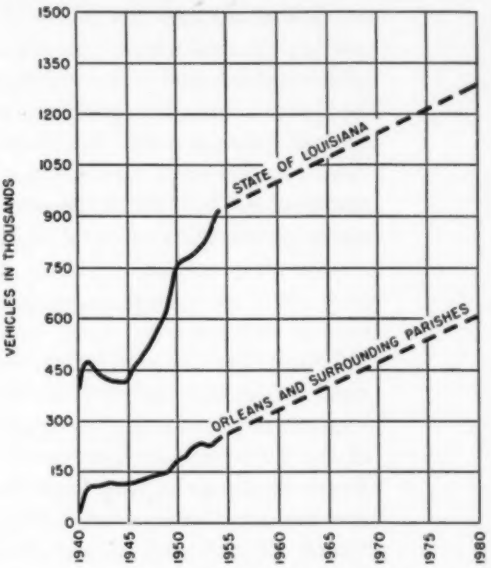


FIGURE 3. Vehicle registration.

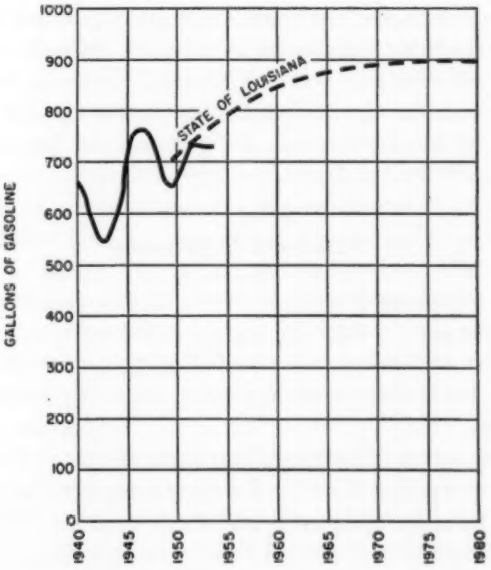


FIGURE 4. Gasoline consumption per vehicle.

Today, through the efforts of the city and various railroad companies, the tracks have been consolidated and lead to a new union passenger terminal. At each point where the tracks meet a major boulevard there is a grade separation with the net result that the arterial plan proposed for the city is rapidly becoming a reality. There are presently nineteen grade separations and three pedestrian underpasses throughout the city, with five others being built in the development of the arterial plan.

Pontchartrain Expressway

When the general plan for the arterial system was accepted in principal by the state and city, the department of highways engaged an engineering firm to prepare preliminary plans for the first section of the Pontchartrain Expressway. It will extend from the Airline Highway along the New Basin Canal right-of-way, across Claiborne Avenue into Calliope Street and terminate in the vicinity of Camp Street. Their report established the several stages under which the facilities were to be constructed so as to provide a useful facility after the completion of each successive stage.

The first section of the expressway is now under construction and is scheduled for completion to coincide with the opening date of the new Mississippi River Bridge, which is being built as a toll facility by the Mississippi River Bridge Authority. The expressway is financed by the department, the city and the Bureau of Public Roads, and will be toll free.

West Bank Expressway

The report recommended the construction of a limited access boulevard from the foot of the new bridge on the west bank of the Mississippi River to the junction of US Highway 90 near the existing Mississippi River Bridge, as a second stage improvement in the arterial plan.

The department of highways has prepared the construction plans for this recommended West Bank Expressway, and the section from Marrero to a point in Algiers is under construction. The remaining sections of this facility are scheduled for early letting to contract.

Upon completion of the Pontchartrain and West Bank Expressways and the connecting link over the toll bridge, the major recommendations will have been accomplished with the exception of the River Front—Elysian Fields Expressway section along the river front to and over Elysian Fields to the junction of the eastern approach highway on Gentilly Road.

Because of the difficulty in providing access to the new bridge and constructing an elevated section over the railroads along the river front, this proposed routing has been abandoned in favor of a routing over Claiborne Avenue from the expressway to the main highway approach to the east, now under construction between Gentilly Road and Lake Pontchartrain.

Mississippi River Bridge

The report recommended as an integral part of the city's arterial plan, a bridge across the Mississippi River near the business district. The proposal was not new; records indicate as early as 1919 a report on the feasibility of such a structure was prepared. In 1929, George Hero and Allen B. Hackett applied for and received a permit from the United States War Department to construct a bridge with a span of 1760 feet. The elevated approach roadways to this proposed bridge were unusual in that each was in the form of a helix with a diameter of several hundred feet. It is understood that the structure could not be financed.

On the basis of the 1946 recommendations the department applied for and received from the Department of the Army a permit to erect a bridge having a span of 1800 feet at Calliope Street. It was evident from the beginning that the facility would be too costly to construct by the department as a toll free structure.

A consulting firm was engaged to make studies and recommendations to include a report on traffic and revenue for a toll-financed structure and a report on the feasibility and cost of a comparable subaqueous tunnel.

That which started as a single report on an economic location, type, and span arrangement, developed into a series of reports involving two types of structures, three or four locations and about twenty different span arrangements in an effort to obtain a permit for a

structure that could be financed with the revenues that the facility could be expected to produce.

Following the recommendations of the consultants a new permit was applied for at a new location, but due to opposition from navigation interest it was denied. In the meantime the original permit held by the department lapsed. An application was submitted to the Department of the Army for the renewal of the Calliope Street permit. This was renewed for the clearance of 1800 feet, but the vertical clearance was increased from 135 to 150 feet which adversely influenced the approach grade on the New Orleans approach.

The Louisiana Legislature by Act 7 of the regular session of 1952 created the Mississippi River Bridge Authority. The Authority was organized and established to construct, maintain and operate the proposed bridge which is to be financed partly by tolls levied on vehicular traffic and partly by a state grant-in-aid. Eventually the bridge is to become toll free.

The Authority, after its creation, assumed the activities of the department and the Bureau of Public Roads and has carried the project forward. The bridge is now under construction and is scheduled for completion in 1958.

Greater New Orleans Expressway

Another major project now being built in the area is a causeway across Lake Pontchartrain, commonly known as the Lake Pontchartrain Causeway. The toll facility is being constructed by the Greater New Orleans Expressway Commission.

Local planners have long contended that a causeway over the middle of Lake Pontchartrain might carry considerable northbound traffic across the Lake to a connection with US 190. From the results of the traffic study conducted by the department, highway officials had concluded the project was not economically feasible. Nonetheless, it was desired to have an unbiased expert opinion on the matter and therefore the department requested a study of the feasibility of the project when the 1946 arterial plan for New Orleans was prepared.

The report stated, "Traffic around the northern shore of Pontchartrain by present roads is not great, and by improvement of these

roads satisfactory travel can be assured. Obstructions are absent and the time saved by a new causeway over the Lake at its greatest girth is hardly worth $20,100,000."

Subsequent studies by consultants employed by the Expressway Commission developed a plan for financing the facility from tolls and state grant-in-aid. Bonds were sold to provide funds for constructing the facility. The department was authorized to expend $5,000,000 on certain roads and approaches to facilitate the movement of traffic to the toll structure, but beyond this the project is entirely an activity of the Expressway Commission.

To finance this project forty-six million dollars' worth of revenue bonds were sold, bringing the cost of the causeway and approach roads to fifty-one million dollars. This causeway, scheduled for completion in September of 1956, will be the world's longest over-water highway bridge.

Interstate Highways in New Orleans Area

The original New Orleans traffic survey was being conducted when the report of the National Interregional Highway Committee outlining and recommending a national system of interregional highways was submitted to Congress in January, 1944. The survey data were employed in designating the location of the interstate route through New Orleans. The Pontchartrain Expressway now under construction formed a part of the routing.

Interstate legislation recently passed by Congress provides for the completion of the entire national system of interstate highways in a thirteen-year period, to be financed with 90 percent federal and 10 percent state funds.

This legislation has motivated the department to renew the study of the New Orleans area to account for any changes in conditions and to locate more definitely the interstate routes throughout the city and surrounding area.

Consideration was given to conducting a new metropolitan area traffic study, but due to the magnitude of such an undertaking and because the location of the Pontchartrain Expressway and its interchange with Claiborne Avenue is controlled by existing and programmed construction and by the Mississippi River Bridge crossing

site, it was decided to up-date the 1944-45 traffic data to the design year of 1976 by expansion factors in lieu of a new traffic study.

Consulting engineers were engaged in the fall of 1955 by the department to up-date the traffic data and to designate the routing of the interstate highway from a connection with US Routes 61 and 51 near LaPlace, Louisiana, west of New Orleans, to a connection with the interstate route now under construction north of US 90 on the easterly edge of New Orleans.

The proposed project is routed through five different rural suburban, or densely developed urban areas, each of which is expected to have a different rate of population growth. Traffic expansion factors were determined by the consultants for each of these areas. This was accomplished by determining the persons per vehicle and gasoline consumption per vehicle ratios, which were then combined to form a factor representing the increased vehicular usage per person from 1944 to the design year.

Accepted population predictions for metropolitan New Orleans were then carefully studied in conjunction with recorded traffic counts, the proposed land uses, and the present population distribution and densities for each of the separate areas. From these data it was possible to estimate a reasonable rate of growth and design-year population for each of the areas. These ratios were then combined with the increased vehicular usage per person factor and added to a factor for induced traffic movement.

From these analyses, the known 1944 traffic movements for each area were expanded to the 1976 design year by factor and the resultant data were used to determine the routing which provides the greatest traffic service as well as freeway design characteristics of pavement widths, interchange types, and location of access points.

The routing designated by the study between the control points at LaPlace to the eastern edge of New Orleans is shown on Figure 5.

From the intersection of Pontchartrain Boulevard and the proposed interstate route from the west, two adopted routings through New Orleans are shown. One follows along Pontchartrain Expressway to an interchange with Claiborne Avenue, thence over Claiborne Avenue and across a developed area to join the northern routing of the interstate along Florida Avenue. The addition of the Florida Avenue routing was made possible when the unassigned

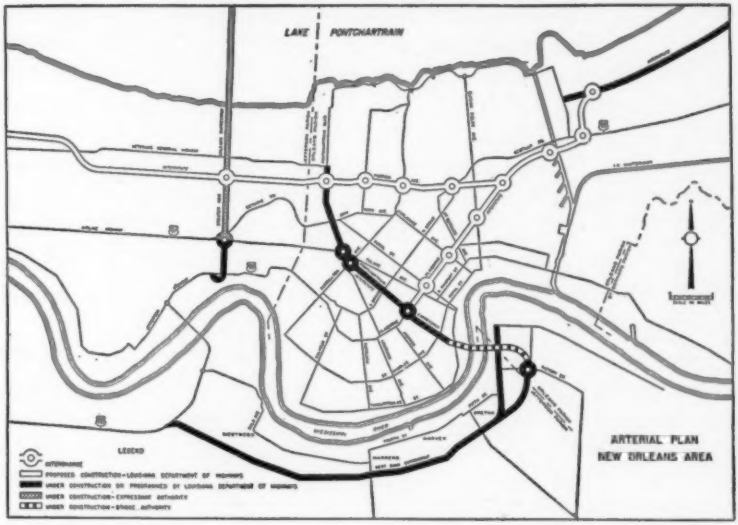


FIGURE 5.

mileage of the original 40,000 miles of the interstate system was recently designated by the Bureau of Public Roads.

Conclusion

In the last decade an ambitious arterial plan has been devised for the New Orleans Area. Improvement of the plan has advanced as rapidly as state, city and federal funds have become available for construction.

Because the toll authorities have financed the New Mississippi River Bridge and the Pontchartrain Causeway with toll revenue-producing bonds, improvements to the arterial plan are several years ahead of any schedule possible with normal revenues from state, city and federal sources.

Completion of the new Mississippi River Bridge coincident with the Pontchartrain Expressway and the West Bank Expressway is essential to obtaining the maximum benefit from their development and justifies toll financing.

To date, projects totaling 170 million dollars have been placed

under construction or programmed on the arterial plan. The remaining portions of the interstate routings not now under construction will cost an additional 200 million dollars. Therefore, the arterial plan as now adopted will represent an investment of 370 million dollars when completed.

Obviously, as the city grows, additional routes will be required to serve the new area and increasing traffic volumes. As the plan is developed, traffic patterns will change and it will be necessary to continue dynamic highway planning to appraise the changing condition. A new metropolitan area traffic survey will be sorely needed to perform this function.

The arterial plan has been devised from the results of traffic surveys, and the officials of the governmental agencies have been aided by outstanding consultants in all phases of planning. One can point with pride to what is considered an outstanding example of cooperation between the various levels of government backed by public support. It is testimony to the fact that the job is never too large or difficult to accomplish when all interested parties work together.

Controlling Highway Access

J. W. GUYTON

Mr. Guyton is engaged in graduate study in Traffic Engineering at the University of Illinois. As co-winner of the 1955 C. C. Wiley Traveling Award, he spent eleven weeks observing highway transportation and construction in fifteen western states. Mr. Guyton, a graduate civil engineer, is a member of the student chapters of both the American Society of Civil Engineers and the Institute of Traffic Engineers.

SINCE the turn of the century, highway engineers have worked to provide adequate highways for the automobile. At first, roads consisted largely of dirt or gravelled routes along principal lines of communication.

For some years following the appearance of the automobile, only modest effort was made to improve these roads. The absence of funds and a myopic point of view caused roadway facilities to fall far behind automotive requirements. An obvious need for improving transportation led to the construction of hardtop surfaces which partially met the public demand to "get the vehicle out of the mud."

With the automobile's greater speed and power and its increasing size and use, engineers became aware of the need for better road alignment, stronger and wider pavements. The important point, however, is that highway development lagged behind vehicle development. Unfortunately, this is true today.

Many miles of the highway system in the United States, inadequate for present as well as future needs, are not necessarily structurally deficient but are inadequate geometrically and functionally. This inadequacy is caused by intersectional, medial, internal, and marginal interferences which contribute to increased highway accidents, operating costs, and travel times, and to reduced highway capacity.

Much of the problem was created by the vast increases in traffic after World War II, coupled with the exigencies of war that prohibited new highway construction for the duration. Thus today, the nation is faced with traffic strangulation.

Many good, adequate highways have gradually been hemmed in by marginal developments until they are congested, unsafe, and altogether unsatisfactory for motorists. Widening or other major remodeling under such hemmed-in conditions is always expensive. Cities are so choked with traffic congestion that business is moving to the suburbs to such an extent that some communities are experiencing a declining economic condition.

This situation threatens our national welfare which is largely determined by our ability to transport goods quickly and economically over long distances. One deduces that a primary function of highways today is to serve long-distance, through-traffic; however, there are other important functions of all highways.

Defining Highway Purpose

In general, the purpose of highways is to provide access to abutting property, facilitate the needs of the general public, serve through-traffic, and contribute to the requirements of national defense.[1] Because of conflicts resulting from the use of a given road, geometric inadequacies may develop in these various functions if one route is used for several types of traffic.

For example, traffic on a highway serving abutting property has the characteristics of low to moderate speeds and frequent turning movements, whereas through-traffic characteristics are generally the opposite—high speeds and few turning movements. These different characteristics do not blend smoothly.

For many years a solution to this congestion problem was the construction of highway by-passes of downtown districts. This theory proposed that removal of through-traffic from downtown areas would benefit both types of traffic. Local shoppers in the business district would contend with less congestion and through-traffic would not be impeded as much by standing or slow-moving vehicles.

Each time this principle was applied, the same results eventually occurred. Commercial establishments and other developments would squeeze alongside the bypasses until these became as congested as the downtown route formerly was. Hundreds of miles of

[1] May, Adolf D., a thesis, "An Evaluation of Certain Limited Access Highways," Purdue University, January, 1955, p. 1.

first class highway facilities, intended for moving traffic quickly through cities, were built throughout the country only to have their capacities greatly restricted by the growth of roadside establishments or numerous entrances and exits from the highways. Parking along these routes added to the confusion until finally traffic could barely creep over what was formerly a high-speed, arterial route.

One can readily perceive that by preventing marginal development along a highway and limiting intersections of all types, most of the congestion from conflicting uses can be eliminated. Especially during the last six or seven years, a relatively new[2] design principle of access control of highways has been increasingly used. In applying this principle of highway design, however, those in charge have encountered problems. Most of these difficulties concern laws controlling the establishment of such routes and payment of just compensation for land taken or damaged in building these facilities.

Nomenclature Defined by AASHO

Before considering these legal problems, the principles of access control of highways and certain definitions should be clearly understood. The following were prepared by the Special Committee on Nomenclature and adopted by the American Association of State Highway Officials.

Local Street or Local Road: A street or road primarily for access to residence, business, or other abutting property.

Expressway: A divided arterial highway for through-traffic with full or partial control of access and generally with grade separations at intersections.

Freeway: An expressway with full control of access.

Parkway: An arterial highway for noncommercial traffic, with full or partial control of access, and usually located within a park or a ribbon of park-like development.

[2] Even though the first legislation for freeways was adopted in 1937, not until after World War II did widespread use of this principle start.

Frontage Street or Frontage Road: A local street or road auxiliary to and located on the side of an arterial highway for service to abutting property and adjacent areas and for control of access.

Cul-de-sac Street: A local street open at one end only and with special provisions for turning around.

Dead-end Street: A local street open at one end only without special provision for turning around.

Control of Access: The condition where the right of owners or occupants of abutting land or other persons to access, light, air, or view in connection with a highway is fully or partially controlled by public authority.

Eminent Domain: The power to take property for public use with just compensation therefor.

Condemnation: The process by which property is acquired for highway purposes through legal proceedings under power of eminent domain.

Inverse Condemnation: The legal process by which a property owner may claim and receive compensation for the taking of, or payment for damages to, his property as a result of a highway improvement.

Police Power: Police power, in general, may be considered the power of the government to enforce the principle that no one has the right to conduct himself or to use his property so as to injure the rights of others.[3]

Just Compensation: A full and fair equivalent for the loss sustained by the owner as a result of taking or damaging of private property for highway purposes.

Damnum Absque Injuria: An injury received without the violation of a legal right.

[3] Enfield, Clifton W. and John C. McLean, "Controlling the Use of Access," Highway Research Board, Bulletin 101, *Trends in Land Acquisition*, 1955, p. 73.

Highway access control imposes many restrictions on the design and use of a highway facility. To broaden the definition somewhat, and make it less technical, one may say that the principle of controlled access permits traffic to flow more freely and continuously at road speed, with greater safety, without interference or potential interference from the entrance, exit, turning, or crossing of any other vehicle or pedestrian; and with less interference from stopping or parking.

The Principle of Controlled Access

The traveler is permitted to make turns, entrances, exits, service stops, and all other necessary maneuvers but under controlled and safe conditions.[4] However, there are two degrees of access control, full and partial. Full control of access means that the authority to control access is exercised to give preference to through-traffic by providing access connections with selected public roads only and by prohibiting crossings at grade or direct private driveway connections.[5] Partial access control differs in that there may also be some crossings at grade and some private driveway connections.

The objective of controlling highway access thus is to provide the most economic and safe type of facility possible for the expeditious movement of traffic particularly in and through congested areas. Though such routes are intended for through-traffic, local traffic can use such facilities advantageously, especially when local service roads are built in conjunction with the controlled access highway.

Controlled access facilities offer greater safety, fewer restrictions, preserved capacity, economy of automobile operation, less travel time, increased abutting land values, better aesthetics, and future improvement at minimum cost. In the Detroit metropolitan area, a one and a half-mile trip on the Davidson Limited Highway now consumes only three or four minutes, whereas it previously required from twenty to thirty minutes.[6] Similarly, the trip from Pasadena

[4] Graham, A. H., "Controlled Access," *American Highways*, vol. XXXIV, No. 3, July 1955, p. 6.

[5] Definition from those prepared by the Special Committee on Nomenclature for the American Association of State Highway Officials.

[6] Cunnyngham, W., "A Lawyer Looks at the Limited Access Highway," *Proceedings*, American Association of State Highway Officials, 1947, pp. 32-41.

to Los Angeles, California, on 5.8 miles of the Arroyo Seco Freeway, has been reduced by twenty-five minutes. On the Boston Central Artery, trips that formerly required eighteen to twenty-five minutes on city streets are now made in two or three minutes.[7]

Comparisons of accidents on limited access highways and on regular state and US numbered routes have shown that accident rates on controlled access facilities are materially lower.[8] Capacity is preserved by eliminating marginal interference of parking and traveling directly into and out of roadside developments. With respect to the advantage of increased land values, the California Division of Highways has made many studies showing the beneficial effects of expressways on adjacent property.

Probably the most important study was made by the Texas State Highway Department on land values and land use along the Gulf Freeway.[9] This study showed increased market values of properties adjacent or very close to the facility to a greater extent than in any other section of the city during a five-year period after completion of the freeway. This same land area showed increases close to the median of increases in all area groups studied for market values during the five years preceding the period of potential influence of the freeway. The study provided clear evidence that the Gulf Freeway has encouraged development of adjacent property as well as to increase its value. Studies in other cities substantiate these findings.

Disadvantages of Limited Access

There are also disadvantages to limited access highways. Generally they require more area and are more expensive to build than other types of high class roads. In some areas, the additional right-of-way cost may exceed the actual construction cost. This added expenditure is not unwise when one considers that an express highway will not have to be abandoned at some future date because of its becoming inadequate.

[7] DeMarsh, Leo F., "John F. Fitzgerald Expressway, Boston Central Artery," *Traffic Quarterly*, October, 1956.

[8] For instance, see "Let's Build Safety into our Highways," Carl E. Fritts, *Highway Magazine*, Sept. 1955, p. 209; and "Economics of Operation on Limited Access Highways," A. D. May, Jr., Highway Research Board, Bulletin No. 107, 1955, pp. 49-62.

[9] "A Study of Land Values and Land Use Along the Gulf Freeway in the City of Houston, Texas," L. V. Norriss Engineering Company, Texas Highway Department, and Bureau of Public Roads, 1951. *Traffic Quarterly*, October, 1952.

Another disadvantage is in causing loss to a few to obtain benefits for the many. For instance, because access is limited to certain, well defined places, a few motorists may have to drive farther than they would if the road were not a controlled access facility. This is known as circuity of travel.

A similar disadvantage is caused by diversion of traffic in rebuilding a highway. The Illinois Division of Highways, in reconstructing US 150 as a limited access highway, re-routed the road outside the city limits of Champaign-Urbana to benefit the majority of motorists, who are through-travelers. As a result, most of the traffic which formerly passed a gasoline station or other business enterprise does not now approach near enough to see them. This diversion of traffic obviously benefits many: yet a few who have businesses on the old route will suffer, at least temporarily.

From diversion of traffic and circuity of travel, two major causes of litigation find their bases for legal action. Several other legal aspects also create problems. One of the greatest deterrents to controlling highway access stems from various interpretations of the rights of the states to control the access of abutting property owners. In many cases court rulings have been inconsistent and unpredictable, even within the same state.

Part of this inconsistency is due to the lack of uniformity among the freeway laws of different states, but some arises from varying applications of general principles upon which few courts actually disagree. Thus the first step is to understand the basic laws and principles regarding rights of access.

Common Law Rights

The courts have recognized that abutting property owners have certain rights in existing streets and highways; deprivation of the rights, even for public use, must be compensated for under the just compensation clauses of our federal and state constitutions. These rights include the right of access, the right of visibility, and the right to the flow of light and air from the street to the property.[10] The precise origin of the right of access is somewhat obscure.

[10] Eminent Domain, 18 Am. Jur. secs. 181-185; 49 ALR 330. Also see *Legal Aspects of Controlling Highway Access*, David R. Levin, 1945, p. 14.

According to early English law, abutting property owners had an inherent right of ingress to and egress from the roads abutting their property, probably because the roads' function at that time was largely land service. In the United States, the first case to intimate that property owners might have a property interest in adjacent streets was decided in Kentucky in 1838.[11]

In part, the court stated that "the streets of Louisville were designated, not only for subserving the public purposes for which this town was established by law, but also for the especial convenience and enjoyment of such persons as should purchase and hold lots contiguous to them. The title to such lots carries with it, as essential incidents, certain services and easements, not only valuable and almost indispensable, but as inviolable as the property in the lots themselves."

In early cases, the courts generally held that where the public had only an easement for street purposes and the abutting owner had fee title to the land, the placing of facilities thereon which *were not proper street use* and which interfered with access constituted a servitude upon such fee title to the street land and therefore required payment of compensation to the abutting owner.[12]

In cases where the abutting owner did not own fee title to the street, however, many early court decisions held that he was not entitled to compensation for obstruction to access, although in many instances the decision was based upon the court's finding that the offending facility was a proper street use. Still, many courts emphasized the difference between an abutting owner who owned the underlying fee in a street and the one who did not. Obvious inequities could result from this since an abutting owner might suffer great damages by obstruction of his access, irrespective of the ownership of the title to the street area.[13]

Finally, in the 1880's, a series of cases in New York more or less abolished the distinction of ownership since they held that an abutting owner has a right of access between his property and an adjacent public street and that any material interference with such rights

11 Lexington and Ohio R. Co. v. Applegate, 8 Dana 289 (Ky. 1839).

12 Eminent Domain, 18 Am. Jr., sec. 190; 3 Nichols, Eminent Domain, secs. 10.31 to 10.31(3), (3rd ed. 1950).

13 Enfield, Clifton W., "Access Control Will Relieve Our Highway Strangulation," *Traffic Quarterly*, July 1955, p. 299.

of access by a nonstreet use requires compensation.[14] Also, in 1883, the State Supreme Court of Colorado declared the existence of a right of abutting land owner in a street owned in fee by the city. The court even described this right as an easement, for the landowner has rights therein not shared by the general public.[15]

Thus the courts in creating a private right in public land by judicial decision have produced a strange situation. When a public body acquires fee title to property and constructs on such property a public highway, certain rights of access are granted legally to abutting property; yet no such right is created when fee title to land is obtained by an individual, or by the public, for uses other than public road purposes.[16]

During colonial days it was natural for the courts to award private rights in public roads. The primary purpose of roads in those times was to afford farmers, ranchers, and other rural residents access to town and market and to link together the small settlements within the country. Besides, abutting landowners usually not only donated land for the roads but also assisted in their construction. That the law is a natural product of the times can be realized from the following comment of Justice Holmes:[17]

> The life of law has not been logic; it has been experience. The felt necessities of the time, the prevalent moral and political theories, intuitions of public policy, avowed or unconscious, even the prejudices which judges share with their fellow-men, have had a good deal more to do than the syllogism in determining the rules by which men should be governed.

The big problem now is to determine when this principle requires payment of compensation to a landowner whose access has been curtailed in some manner. Since the courts of each state are responsible for determining the particular interest of abutting landowners in access to highways, many different conclusions have been formulated. The following statement from the case of Sauer v. New York[18] indicates the court's recognition of this fact:

> The right of an owner of land abutting public highways has been a fruitful source of litigation in the courts of all the states, and the decisions have

14 Lahr v. Metro. El. Ry. Co., 104 NY 268; Bohm v. Metro. El. Ry. Co. 129 NY 576.
15 City of Denver vs. Bayer, 7 Colo. 113.
16 Enfield, *op. cit.*, p. 300.
17 Holmes, Common Law 1 (Little, Brown Co. 1948).
18 Sauer v. New York, 206 U.S. 536, 548 (1906).

been conflicting, and often in the same state irreconcilable in principle. The courts have modified or overruled their own decisions, and each state has in the end fixed and limited, by legislation or judicial decision, the rights of abutting owners in accordance with its own view of the law and public policy.

Few, if any, courts today would disagree with the general principle that every member of the public has a right to use a street for passage and to have it unobstructed; nor would they rule against a property owner's having a right of access to an existing public street or highway abutting his property. However, in most litigation concerning proposed limited access facilities, these two principles are in direct conflict with each other, and one must yield to the other. This is the problem the courts face day after day—rights of the individual versus rights of the public.

State Laws Concerning Limited Access

From the beginning of the concept of controlling highway access, most state highway departments realized that before they could begin to plan for such facilities to protect the highway and motorists from encroachments of individuals and business establishments upon the rights-of-way, they required state laws giving the departments authority to construct such highways. Gradually, since the adoption of the first Freeway Act in 1937, state after state has sanctioned controlled access highways through the interpretation of state constitutions, from state statutes, or from judicial decisions of state courts, until by 1955 forty-four states had legalized expressways.[19]

Some states limit the roads over which the laws apply, as in Delaware where the authorization only includes a two-mile section of roadway. Minnesota is enabled to construct limited access facilities by a favorable State Supreme Court decision; Missouri, by a state constitutional provision; North Carolina, by the legal interpretation of the original highway laws.

[19] These states are Arkansas (1953), California (1939), Colorado (1941), Connecticut (1939), Delaware, Florida (1943), Georgia (1949), Idaho (1951), Illinois (1943), Indiana (1945), Iowa (1955), Kansas (1953), Kentucky (1946), Louisiana (1942), Maine (1939), Maryland (1941), Massachusetts (1943), Michigan (1941), Minnesota, Mississippi (1949), Missouri (1945), Montana (1955), Nebraska (1953), Nevada (1955), New Hampshire (1943), New Jersey (1945), New York (1937), North Carolina, North Dakota (1953), Ohio (1941), Oklahoma (1945), Oregon (1947), Pennsylvania (1945), Rhode Island (1937), South Dakota (1953), Tennessee (1955), Texas (1943), Utah (1945), Vermont (1955), Virginia (1942), Washington (1947) West Virginia (1949), Wisconsin (1949), and Wyoming (1949).

New Mexico is the only state which passed a controlled access law and had it repealed at a later date. Of the four states not having limited access laws, several seem to be contemplating such action in the near future.[20]

The outstanding difference between laws of the several states regarding limited access facilities concerns the payment of just compensation. Almost half the state constitutions require that compensation be paid only if private property is taken or appropriated by the government: the others also require compensation for damage to property caused by a public improvement whether any land is taken or not.

As a further complication, the courts of all of the states have not interpreted these provisions literally. Then, too, the distinction between "taking" and "damage" is unclear because of the general rule that the destruction of property constitutes its taking, and the difference between damage and destruction is only a matter of degree.

In South Carolina, courts have interpreted that State's constitution as requiring compensation for damage to property without a taking, although the constitution itself refers only to property "taken."[21] Conversely, in Pennsylvania, courts have held in several cases that damage without a taking entitled the landowner to no compensation; yet the constitution of that state contains a provision for compensation for property taken or injured under certain circumstances.[22]

Compensation Laws

In those states requiring compensation only for the taking of property for public use, the necessity of exercising eminent domain to limit access seems to depend upon whether the property owner is regarded as having a property right to unrestricted access to an abutting highway; if there is such a right or easement, the abutter is a part owner of the land occupied by the road. Extinguishment of this easement by prohibiting vehicular access would naturally amount to a taking of that property right and would require compensation.

20 May, *op. cit.*, p. 14. Also for a discussion of differences, see "Expressway Programs Need Good Legal Tools," David R. Levin, *Roads and Streets*, June 1954, p. 51.

21 Reese, Harry B., "Legal Aspects of Limiting Highway Access," Highway Research Board, Bulletin 77, 1953, p. 36.

22 *Ibid*, p. 38.

In the light of facts presented and actual court rulings, however, the access rights of a landowner abutting a public highway appear to be more limited than is generally supposed, for the existence of an abutter's right of access against certain kinds of obstruction does not establish such a right for all purposes.

Even though some courts have noted that access to adjacent land was the original purpose of the highway and that access is necessary to land use, this property right or easement is good only against non-highway uses, a limitation of which some courts have overlooked.[23]

Besides, the use of highways in many instances has changed considerably since the first route was built. Under this view, there is no right of access good against improvements designed to facilitate public travel; and if there is no property right, there is no taking of property for which compensation must be paid when access is curtailed.

In numerous states which constitutionally guarantee compensation only for "taking," it has been held that construction of a viaduct or highway bridge approach which destroys access to the front of an abutting lot does not amount to a "taking" if other access is still available. This subordination of the abutting landowner's interest in access has been explained by the assumption that obstruction to access must have been contemplated when the highway right-of-way was originally purchased, and that the possibility of such obstruction must have entered into the compensation paid.

To allow recovery when access is obstructed would therefore amount to paying the landowner twice. However, if the means of access being curtailed is the only available way of ingress and egress to and from the land, the land would become useless for all practical purposes. This is generally ruled a "taking" of that land, for which compensation must be paid.

But this allowance of compensation does not amount to a recognition of easement of access as being a property right. However, if some part of an owner's land is physically taken—as for widening the right-of-way—then he is entitled to compensation for not only this taking but also to all damages caused by the taking, which would include the drop in market price due to a restriction of access.[24]

[23] *Ibid*, pp. 38, 39.
[24] *Ibid*, p. 41.

In those states affording compensation for "damage" as well as for a "taking," the inquiry is not whether there is a property right of access, but whether the impairment of access has damaged the abutting land. The damage thus protected against is generally deemed an injury special or peculiar to the land involved and not merely damage common to the public at large. Or, as the courts often define it, the damage to be recoverable must be different in kind, not merely in degree, from that sustained by the community generally.

If the courts were to construe the "just compensation" clauses to require payment for all injuries imposed upon persons or property by acts of government, then government itself would be impossible. Thus a property owner should only receive compensation, under these clauses, for that special injury which he receives over and above such common injury as is suffered by the general public. As one case so stated:[25]

> The phrase "over and above such common injury" has much significance. It concedes to all a certain damage, a *damnum absque injuria*. It implies that there may be cases where the removal or relocation may work some special damage not common to other abutting owners or the general public, in which event compensation shall be made. But, obviously, the nature of special damage does not mean individual damage. If it should or could be so construed, the result would destroy the principle.

In too many cases, it seems, the courts have been too liberal in insuring the individual against loss occasioned by the exercise of governmental power, while they have not given enough weight to the interests of the public in order that government will not be unduly restricted in its functions for the public good. It is uniformly recognized that not all consequential damage to private interests was intended to be included within the scope of eminent domain clauses.

Circuity of Travel

Under this doctrine many courts have ruled that to make travel by motor vehicle safer and to adapt the highway and street system to the increasingly heavy burden of traffic, public authorities can devise and enforce traffic regulations such as one-way streets, grade-crossing

[25] Wolf v. City of Los Angeles, 49 Calif. App. 400, citing Reardon v. San Francisco, 66 Calif. 492, 6 Pac. 317.

elimination, prohibition of U-turns and left turns, divided highways, and other restrictions. The legal sanction for such action in the public interest naturally has been the police power.

By such action, a property owner may be forced to travel in a less direct route to reach his destination. However, judicial authority has usually held that such circuity of travel is noncompensable in the absence of arbitrary action on the part of the highway agency. Mere circuity of travel does not of itself substantially impair ingress and egress since any resulting interference is but an inconvenience shared in common with the general public, and necessary in the public interest to make travel safer and more efficient.[26]

The owner of abutting property has no absolute right, as against the public, to insist that the adjacent street always remain available for use in the same manner and to the same extent as when it was constructed. This has been ruled in the best considered cases.[27] Any inconvenience to a landowner after he is on the street and wishes to travel over the system of public streets is a damage suffered in common with the general public and does not constitute an impairment of his easement.[28]

Diversion of Traffic

There have been cases in which the defendants asked for compensation for professed losses due to relocating highways or streets. However, it is established doctrine that if normal traffic is rerouted, or if another highway is constructed which diverts a substantial amount of traffic and the value of an abutter's property is thereby diminished, the abutters have no right to compensation by reason of such rerouting or diversion of traffic.

The landowner has no property right in the continuation or maintenance of the flow of traffic past his property.[29] Even though the value of the land occupied by a gasoline station, for example, may be substantially depreciated by such relocation of a main route, the injury is not regarded as damage in the constitutional sense.

[26] Levin, David R., *Legal Aspects of Controlling Highway Access*, 1945, p. 29. See also the following cases; Jones Beach Boulevard Estate, Inc. v. Moses, 268 N. Y. 362; Commonwealth v. Nolan, 189 Ky. 34; Cavanaugh v. Gerk, 313 Mo. 375; N. Y., Chicago and St. Louis R. R. v. Bucsi, 128 Ohio St. 134.

[27] Levin, *op. cit.*, p. 33.

[28] See 49 ALR 333; 93 ALR 639.

[29] Levin, *op. cit.* pp. 33, 34.

One of the perplexing questions for courts to decide in awarding damages due to construction of urban freeways, is whether the creation of a cul-de-sac constitutes *damnum absque injuria* or not.

Cul-de-Sac Doctrine

Some courts have declared that this action requires compensation when access is blocked to the next intersecting street in one direction, even though access still remains in the opposite direction.[30] Yet this same situation has been held not to be a taking of private property within the prohibition of the due process clause of the federal constitution.[31]

Many other courts have steadfastly refused to award compensation under such circumstances, maintaining that injury, if any, differs only in degree but not in kind from the damage suffered by the general public.[32] Courts so holding seem to have followed the rule supported by a majority of the courts, and founded on sounder logic.

Actually a cul-de-sac, particularly in a residential district, is deemed highly desirable today. Two hundred cul-de-sac streets in and around Los Angeles were used in a study which determined that for single and multiple residential uses no diminution in value occurred by their development, and in numerous cases benefits were enjoyed. Throughout California, sales of residential properties situated on cul-de-sacs have since verified this fact. City planners consider the design of residential districts with such streets as very desirable.

Eminent Domain vs. Police Power

Reduced to its simplest form, the issue in impairment-of-access cases involves reconciling the conflicting interests of private and public rights—or use of eminent domain proceedings against the use of police power. Just as due process of law protects individuals from public jeopardy, so the police power protects the public from the individual.

30 See cases collected in 49 ALR 330; 93 ALR 639. From Levin, *op. cit.*
31 Meyer v. City of Richmond, 172 U.S. 82, 19 Sup. Ct. 106
32 Levin, *op. cit.*, p. 34.

It is well established and accepted that states through exercise of the police power can restrict or prohibit access to new highways on entirely new locations, providing the state's constitution or by-laws so permit it.[33] This denial of access is not a "taking" of property, per se, for which compensation must be paid since there can be no taking of a right which never existed. Naturally, the state highway agencies would prefer to use the police power to establish controlled access routes along existing facilities also, since by this procedure restriction of access of abutting land owners would be noncompensable.

From the definition and intention of police power, a few individuals will suffer more than others whenever this means is used to establish highway regulations. A state has a right to regulate traffic, without liability for payment of compensation, in the following ways: 1) prohibition of left turns and access between traffic lanes, 2) prescribing one-way traffic, 3) diversion of traffic from a business location, 4) creating cul-de-sacs by closing streets just beyond a tract of land if access to that land is left in one direction to the general network of highways.[34]

In considering freeways constructed with frontage roads and those without frontage roads except where they cross property in such a manner as to afford the only means of access to the property, it seems that no greater burden actually is imposed than is produced by traffic regulations.

As usually conceived by courts and text writers, a private right of access is subordinate to the paramount right of the public to use and adapt the streets for proper street purposes.[35]

However, courts perform a sort of weighing-of-interest test on restriction of access cases. Until the public in general and the courts in particular recognize the great need for and the many benefits of controlled access facilities, many courts will probably continue to award compensation for impairment or restriction of access when such payments are not actually warranted.

[33] See State Highway Commission v. Burk, et al., 265 P 2d 783, (1954), and People v. Thomas, 239 P 2d 914 (1952).

[34] Cunnyngham, W., "A Lawyer Looks at the Limited Access Highway," *Proceedings*, American Association of State Highway Officials, 1947, pp. 32-41.

[35] Enfield, Clifton W., "Controlling the Use of Access," Highway Research Board, Bulletin 101, 1955, p. 74.

Uniformity in laws of the different states is of course desirable, although it is unlikely to happen. From the experience of states with differing laws, however, a list of desirable, even essential, laws can be made.

Recommended Legal Authority

Such a list was summarized by Clifton W. Enfield in "Access Control Will Relieve Our Highway Strangulation"[36] (in part):

1. A clear legislative statement of policy to guide highway authorities and to aid courts in interpreting statutes.

2. Definitions of new words and terms not in common usage and not clearly defined by other statutes or judicial decisions.

3. Authority to locate, relocate, adopt, establish, construct, designate, maintain, and operate access-controlled highways, including the conversion of existing highways into access-controlled facilities.

4. Authority to regulate traffic by signs, markers, and stripes; to control parking and speeds; to establish one-way streets and no passing zones; and to prohibit U-turns, left-turns, and other undesirable vehicle movements.

5. Authority to acquire by purchase or right of eminent domain fee title to or any interest in real property, including rights of access, air, view, and light, which the highway authority deems necessary for public purposes: with such determination of necessity being conclusive in the absence of fraud or capricious or arbitrary action.

6. Rights of access from abutting property to future new or relocated access-controlled highways should be prevented.

7. Authority to provide access from abutting property to access-controlled highways which the highway authority considers in the best public interest.

8. Prohibit the construction, erection, or installation of anything upon highway rights-of-way without permission of the highway authority.

9. Prohibit all advertising upon highway rights-of-way both within and without incorporated cities.

10. Authority to close, separate, or relocate intersecting streets and roads; and to prohibit the connecting of new streets and roads to access-controlled highways without consent of the highway authority.

11. Authority for cooperative agreements between the state and the federal government, counties, cities, and other state sub-divisions in establishing and constructing access-controlled highways.

12. Authority to enforce access restrictions, including the following:

    a. Prosecution of court proceedings to enjoin unauthorized access.

    b. Suspension of an abutting property owner's right to use an access

[36] From *Traffic Quarterly*, July 1955, pp. 309-312.

and closure of the same for all purposes, in the event of violation of use restrictions, until the highway authority is assured that the offending use will not be continued.

c. Making it a misdemeanor to enter or leave a highway at any location, for any use, or in any manner not authorized by the applicable access-control provisions, and providing fines or imprisonment, or both, for violations.

As the grave need for freeways and other limited access facilities becomes more evident, the judiciary tends to favor the public's needs above individual landowner's private interests. This is particularly true in California where earlier adverse decisions are overshadowed by more recent, favorable rulings.

Decisions awarding compensation for access extinguishment or limitation seem to be justifiable in only two instances—when complete access to a parcel of land is denied, and when existing facilities are widened into or reconstructed as limited access routes without providing frontage roads. Possibly, since the laws are the product of the times, these interpretations will become established judicial rulings on compensation in controlled access cases.

New York City's Traffic Presents A Problem Centuries Old

STEPHEN P. KENNEDY

Mr. Kennedy, the twenty-fifth Police Commissioner of New York since consolidation of the city on January 1, 1898, was appointed on August 2nd, 1955. Mr. Kennedy is the seventh career policeman to rise from the ranks to become head of the largest police force in the United States. He took the examination for the police department and became a member of the force on March 22nd, 1929. He was promoted to Sergeant in 1937, to Lieutenant in 1940, and to Captain in 1945. In between his police duties, he studied law, and received his Bachelor of Law degree in June, 1950. He was admitted to the practice of law in the State of New York and also before the Federal Courts in the Eastern and Southern Districts, the United States Court of Appeals, 2nd District, and the Supreme Court of the United States.

FOR the last two hundred years, New York City police organizations have been waging a relentless transportation war—from colonial times, through the Civil War era, and especially now in the twentieth century. In sheer scope and quantity, few cities in the world remotely approach New York in vehicular and pedestrian movement. To refer to New York City traffic as a "problem" is the grossest kind of understatement.

As the citadel of the most industrially progressive nation in history, New York City bears the almost inconceivable burden of keeping billions of wheels rolling through its 6,033 miles of streets—despite gigantic structural metamorphoses, hurricanes, blizzards, floods, and constant repairs to the street system.

To gain a comprehensive understanding of New York City street movement, an observer would have to take to the air and view teeming narrow streets, vast highways, old and modern bridges, tunnels, railways, subways, elevators, ramps, ferries and airports. The observer would soon note that the movement is mainly horizontal in a renowned vertical city.

The Mayor manifested prime concern in New York City street

conditions when he organized the Inter-Department Council on Traffic in late 1955. This council meets monthly and is comprised of the following members: City administrator, police commissioner, traffic commissioner, sanitation commissioner, mayor's representative, and two city councilmen. Traffic advances developed through this council will be treated later in this article.

Manhattan Island—the Magnet

Manhattan Island, the very heart of traffic enigmas, is only twenty-four square miles in area, thirteen miles long and two and one-half miles wide. It is a powerful magnet drawing vehicles from all sides to the greatest industrial, commercial, financial, and recreational center in the world.

Millions of workers bring New York City business to life. As a consequence Gotham experiences two tremendous traffic convulsions every normal business day: the intake in the mornings between 6 and 9 A.M. and the exodus in the evening between 4 and 7 P.M. Most of this traffic converges upon waterbound Manhattan, with the heaviest concentration on Midtown and Downtown (below 60th Street). The department of traffic estimates that more than 600,000 vehicles enter Manhattan daily below 60th Street alone.

In a 24-hour period, fourteen bridges pour 1,250,000 automobiles, buses and trucks into and out of Manhattan; 200,000 vehicles feed into and out of four underwater tunnels; 6,000,000 riders come out of interborough subway kiosks or from buses at street corners. To this street movement can also be added about 1,000,000 people entering or leaving the city on railroads and ferries daily.

The out-of-town vehicles and pedestrians then intermix in the city's narrow streets already loaded with 1,500,000 vehicles registered locally and jammed with an estimated 3,500,000 people on their way to work. More than 1,000,000 school children must cross the city's streets twice a day. This, without question, makes for the greatest conglomeration of man-made movement any traffic force has ever encountered.

To accommodate internal traffic, there are within Greater New York City fifty-eight bridges connecting four boroughs—Manhattan, Brooklyn, Bronx and Queens. These bridges carried 2,600,000 vehi-

FIGURE 1. Traffic police are responsible for keeping vehicles and pedestrians moving at this intersection on a typical mid-afternoon.

FIGURE 2. Architect's conception of new square-shaped cargo and passenger terminal, superimposed on an aerial view of the North River. Estimated cost of the project is $16,240,000. Parking spaces for approximately 1,000 automobiles will be provided on the roof.

cles for a twenty-four-hour period in both directions, according to counts taken by the Department of Public Works between November 15-17, 1955.

Besides business people and residents, it is estimated by the New York City Convention Bureau that at least 13,000,000 tourists a year visit New York.

Most visitors begin their sight-seeing from the midtown area of Manhattan and disperse in all directions by some motorized means from hotel and entertainment center.

Police Traffic Division—A Thin Blue Line

Millions of motorists entering New York have placed their confidence in the white gloves and shrill whistles of experienced traffic policemen who guide them through traffic congestion and street irritation. Traffic officers are practical men who are vitally interested in the safe and smooth flow of traffic in the metropolitan area. The health and wealth of the city depend on swift and consistent transportation of food, medicines, clothes, and thousands of other items which make for the American way of life.

The Traffic Division of the Police Department, manned by 2,284 specialists, is charged with the unenviable responsibility of controlling millions of vehicular and pedestrian movements in the city's streets. This special division, equivalent to an infantry battalion, serves as a powerful and sensitive unit of governors which move vehicles and humans through narrow, curved, and old arteries of traffic, keeping the lifelines of New York City fluid.

Each traffic policeman acts to control speeds, to avoid traffic jams, to aid traffic flow and enforce safety measures.

There has been no complete answer to the New York City traffic problem and there will not likely be one in the foreseeable future. Simply stated, the volume of traffic in New York City is too great for its street facilities. A firm of engineers in 1929 in a letter on city traffic conditions wrote: "Considering the conditions to be met, the Traffic Division (Police) is amazingly efficient."

It has long been apparent that the solution to New York City traffic does not lie solely in enforcement of street regulations, but rather in the architecture of the city itself.

To understand New York City's traffic situation properly, one must go back to 1609 when Henry Hudson discovered, under the Dutch flag, the greatest natural harbor in the Western hemisphere. The Dutch named their gem "Nieuw Amsterdam" and soon their seaport became a thriving community.

The Dutch settlement was that part of lower Manhattan now known as the "financial district." Surrounded on three sides by water, the Dutch community concentrated on water-front and shipping facilities, paying little attention to street layout, for it was never dreamed in those early days that a city would arise directly north of Wall Street, the northern boundary of New Amsterdam.

In The Beginning

Maps of early Nieuw Amsterdam reveal narrow, winding pastoral streets on the lower tip of Manhattan. The main street was Broadway, which was to become the "Grand Canyon" of the twentieth century.

To the Dutch policeman, called a "schout-fiscal," traffic in New Amsterdam streets was not his problem because police were not charged with the responsibility of keeping horses and carts moving. A policeman's job in those days was to watch warehouses and homes, and to prevent disorder and rowdyism.

As commerce developed and streets above Wall Street grew in crazy-quilt, cowpath design, traffic became a major concern to shipping interests because companies found that their ships could not make schedules when muddy roads caused inland transportation to bog down.

By the time the English occupied New Amsterdam and renamed it New York in 1664, the waterbound community had extended up to Canal Street. At George Washington's inauguration in 1789, "uptown" had advanced to 14th Street and traffic was already a problem to all forward-looking New Yorkers. New York was beginning to take on cosmopolitan characteristics—crowded and dirty streets, heavy accident rates involving horses and carts and people, snarled traffic at unsupervised intersections.

City planners of the early nineteenth century designed new street developments uptown with the aid of surveyors. This resulted in a gridiron street pattern, labelled by Henry James as "petty-fogging

parallelograms." It was believed that since most of the north-south travel would be by water few avenues would be required. By 1811, when the railroads usurped most of the avenues as they were opened, the population spread northward while surface traffic moving in all directions was impeded by the railroad tracks.

Traffic congestion in lower Manhattan had become unbearable when New York's first railroad was chartered by the state legislature. The narrow, curving streets were jammed with vehicles and many ingenious minds were working on the traffic problem. From the Phelps-Stokes collection of Old New York prints, ample evidence is present of serious traffic jams one hundred years ago.

Traffic Court Established

In 1915 following a survey of traffic conditions, New York City established a traffic court. In 1910, fatalities in the streets of New York occurred at a rate of 7.98 per 100,000. In 1915 the rate increased to 11.65 per 100,000. By 1955, the rate increased to 12.4 per 100,000 (652 fatalities out of 8,000,000).

The census taken during November, 1915 showed a movement of 3,407,069 vehicles in the entire city and of 15,645,745 pedestrians past 450 posts guarded by the men of the Traffic Squad each day between 8:30 A.M. and 6:30 P.M.

Judging by the accounts of New York traffic and street conditions since 1856, the present day city traffic is improved.

As New York City now must handle an estimated 600,000,000 vehicles yearly, the traffic division is keenly conscious of a three-cornered contest being waged over street control: Volume vs. Space vs. Safety.

Parking: The Biggest Problem

Someone aptly described the desperate search for a parking space in an American city as "our mid-century malaise: automotive arteriosclerosis."

The great daily scramble for parking space in New York City defies simple arithmethic. If the estimated 2,000,000 vehicles which use the streets daily were parked simultaneously they would prob-

ably take up all the curb space bumper to bumper through the entire city.

Manhattan's modern parking garages and lots are swamped with requests for space; curb parking and metered parking are snapped up shortly after dawn daily, leaving rush-hour drivers frustrated as they rove the streets seeking parking space. This aimless driving greatly adds to the problem of business motorists, fighting against time to show a profit for the day.

Mathematically, the only solution to the parking problem is to recommend that out-of-town vehicles remain out of New York City by means of "perimeter parking," or to devise a vast system of parking lots.

Parking on the city's margins calls for unusual engineering of "transit streets." By this system, out-of-towners would park their cars in the suburbs where buses would bring them into central transportation centers in midtown and other business areas. New Jersey state officials have been pondering the feasibility of building parking lots on the west side of the Hudson River and seeking bi-state cooperation on river-shuttling millions of commuters.

Widening streets cannot keep pace with the increased use of highways. The prohibitive cost of acquiring property prohibits new avenues designed to relieve north-south congestion. New garages of the parking type often cannot be constructed in central Manhattan because of restrictive zoning laws and the stringent building code.

Manhattan traffic problems will not be solved without drastic action involving major changes in the architecture of key streets and the deploying of vehicular streams from obvious bottlenecks.

Holding The Tide

While hundreds of conferences involving traffic commissions, safety councils, and civic-minded individuals and groups took place through the years, traffic in the streets of New York City went on.

In waging a front-line battle, expedients were necessary. Commanders of the traffic division have adopted plausible, common sense ideas to solve immediate problems. Often suggestions from traffic policemen led to the solution of knotty problems. Traffic policemen are the first to know whether an idea is workable or not.

A chronological listing of safety measures taken by the New York City Police Department will probably best portray the dynamic interest taken in public safety by the traffic division and its determination to improve accident rates.

One must note the relationship between the rise of population and vehicle registration and the improvement in safety devices installed to meet growing transportation needs. Most significant has been the constant turnover of traffic expedients—ideas which were once proudly hailed as solutions to the problem but subsequently discarded with the growth of traffic.

Twentieth Century History of New York City Street Movement

Year	*Population*	*Vehicle Registration*	*Traffic Advances*
1900	3,437,202	8,000*	First traffic police were instituted. Known as the "Broadway Squad," stationed along Broadway, from Bowling Green to 59th Street. Their principal duty was to escort pedestrians across Broadway amid horse-drawn wagons.
1905		78,000*	(1903) First printed traffic regulations issued. First mounted traffic police given to police commissioner.
1910	4,766,883	468,000*	(1908) Special authority to make regulations for control of street traffic given to police commissioner.
1915		2,000,000*	First statistics on street accidents. One-way streets introduced. New York Times noted "a great improvement" in traffic congestion.
1920	5,620,048	9,000,000*	Eight additional one-way streets authorized. Red and green oil lanterns added to four-armed semaphores for night use. Hailed as a success. First traffic signal towers erected. Traffic Division increased to 1,000. "Illuminated" policemen idea discarded.

*Totals in United States (rounded figures)

Year	*Population*	*Vehicle Registration*	*Traffic Advances*
1925		19,500,000*	First remote control traffic signal system installed, operating at intervals along Broadway.
1930	6,930,446	797,790**	Engineering bureau of police department organized.
1935		841,715**	
1940	7,454,995	994,769**	(1939) 1,200 miles of city designated for one-way travel.
1945		742,877**	
1950	7,891,957	1,297,686**	
1955		1,490,778**	

*Totals in United States (rounded figures)
**New York City (first record 1930)

The Present Traffic Program

At present a vigorous traffic-improvement campaign is underway at several levels: strict enforcement of the traffic law, safety measures, education of the motorist and pedestrian, and co-ordination of groups dedicated to the local traffic problem.

Safety: The foremost concern of the traffic division is safety. To regulate and expedite traffic is one thing, but to regulate its safety is another. The first step toward reducing accidents, naturally, is to discover what causes them. When one begins to read or study about automobile accidents, he is impressed with the fact that most of them have not one cause but a number of causes.

New York, because of its size, has probably more special problems in traffic control than other cities; as a result almost all the basic types of control apparatus ranging from manual control to radar are put to use. But obviously these controls are still not sufficient to keep motorists driving safely.

Pedestrians: It is at pedestrian safety that the sharpest education spearhead must be directed. While police enforcement of pedestrian regulations has never been popular with the citizen, there is a pressing necessity for it at present to cut down the rate of injury and

death and to save persons from their own careless acts. However, the police department is far too undermanned to serve summonses to car-dodging, barricade-skirting, jay-walking pedestrians and still take care of vehicular traffic.

As early as 1860 New York City traffic experts found that the public is prone to ignore safety devices. The first known safety promotion work started in lower Manhattan before the Civil War when an ornamental iron bridge was erected, spanning Broadway around Fulton Street. To the dismay of the civic-minded builder, pedestrians risked crossing the street rather than climbing the stairs to safety.

Compared with other municipalities, the city has not been unduly strict on pedestrian regulations. The reason is that the volume of human beings using the streets is so great that the traffic lights in Manhattan are often superseded by the hand signal of the traffic officer. The public has thus become conditioned to walking against traffic lights when a break in traffic is seen, and the New Yorker's traditional freedom of pedestrian action remains.

At busy intersections of the city many innovations have been added recently for pedestrian safety. Bright, new-style "WALK" and "DON'T WALK" signs have been installed to either complement traffic officers' hand signals or to act as self-functioning safety devices. But field reports indicate the public flagrantly violates these clearcut injunctions.

If pedestrian accident rate continues to rise, then the only solution to such heedlessness appears to be an anti-jaywalking ordinance.

School Crossing Guards: One and a quarter million children cross the city streets each day on their way to school. At these school crossings and in the vicinity of schools the police department has greatly increased its corps of school crossing guards to 1,100, supplementing the regular patrolmen to cover almost all the city's 2,291 school crossings. This represents the best coverage in the city's history.

Composed mainly of women whose own children are in school, this two-year-old corps is setting an imposing record. Statistically, fewer children have been injured or killed since the guards began their duties. School authorities and motorists have been cooperating admirably.

For the few motorists who break traffic laws in the vicinity of

school crossings, the guards fill out an "observation" report which is turned into the Safety Bureau of the Traffic Division. The violator is then issued a letter of warning. If the traffic violation is serious, a summons is issued and the school crossing guard who noted the infraction goes to court accompanied by a regular patrolman.

The following suggestions have been offered by the police department to parents and guardians, pedestrians and drivers in a program to prevent accidents:

PARENTS AND GUARDIANS

Teach the children the meaning of traffic lights and signs.

Teach the children to cross at the crossing.

Warn the children of the dangers of crossing between parked cars.

Warn the children of the dangers of running into the roadway.

Warn the children of the dangers of "HITCHING RIDES."

Warn the children of the dangers of playing games in the roadway.

Warn the children of the dangers of careless bicycle riding.

Show the children a good example by obeying the traffic lights and signs.

Show the children the safest route to school.

Take the very young children to safe play areas.

If you drive a car, be doubly alert near schools and play areas.

Obey the rules of safe driving—protect your youngsters.

DRIVERS

Don't take chances—accidents happen in a fraction of a second.

Slow down when turning—and be sure to SIGNAL.

Safe drivers are life savers.

It takes more time to report an accident than it does to prevent one.

Slow down at intersections.

Accidents don't happen—they are caused.

Keep your car under control at all times.

Always drive according to conditions.

Don't depend entirely upon your rear view mirror.

Signal before leaving the curb.

Traffic signals and signs are your safety guides.
Drive carefully at all times.

PEDESTRIANS

Cross at intersections only.

Never walk into the street from behind parked cars.

Obey traffic signs and signals.

Wait on the sidewalk—NOT in the street—FOR THE LIGHT TO CHANGE

Before crossing the street—ALWAYS look left and then right.

Watch for turning cars at the intersection.

Walk, do not run, when crossing the street.

When you step off a bus, don't cross the street until the way is clear.

Remember to walk safely today.

Keep your mind on your walking.

The curb line is the danger line for pedestrians—Walk safely.

Be alert when you cross the street.

Use your head, as well as your feet.

(The foregoing traffic safety tips have been suggested as spot announcements on radio and television breaks for safety campaign)

What is Being Done in Enforcement

An old slogan emphasizes the police department's approach to the traffic problem: "Care, Courtesy, Common Sense."

During 1955 there was an increase of 9.6 percent in traffic fatalities; a 4.4 percent increase in injuries and a 3.0 percent increase in accidents.

Within the last year, several steps were taken to tighten traffic enforcement procedures.

Accident Investigation Squad: An accident investigation squad, comprised of six fulltime two-way radio patrol cars and forty-two officers assigned to all boroughs except Staten Island, was created on October 27, 1955, to serve as an added arm of the traffic division in a war against reckless drivers.

Consultations with the district attorney's office via radio-phone by AIS patrolmen were instituted to speed legal processes of individual violations covering intoxication, reckless driving, leaving the scene of an accident, operating a stolen vehicle, and dangerous driving.

A key feature of the AIS is that two specialists work as a team in the patrol car. One officer will handle matters pertaining to evidence, decelerometer and skid marks. The other is a member of the Intoxicated Drivers Testing Unit, an expert in the use of the Hargometer. The value of the latter is shown in the 1,179 chemical tests for intoxication administered in 1955, as compared with 511 in 1954 —an increase of 130 percent.

Traffic Emergency Task Force—Unmarked Cars: While considered fairly successful throughout the country, S-D Day 1955 did not produce favorable results in New York City. As a result the traffic division instituted covert means of catching irresponsible, untrustworthy drivers by using unmarked cars manned by uniformed policemen. These cars monitored thoroughfares where traffic law violators were most likely to operate and where incidence of accidents was high. Thus far, the task force shows the effective use of a minimum force for maximum enforcement. The upward trend in accidents has not only been stopped, it has been reduced.

Since the inception of the unmarked car experiment, a great increase of summonses has resulted and a genuine caution put into the driving habits of the potential traffic lawbreaker. Each weekend since initiating the task force an average of 10,000 summonses for *moving* violations has been issued.

The unmarked police car was developed as an accident preventive device. Safetywise, the unmarked car already has more than justified its incorporation into the traffic division. The unmarked car might be termed "a police car in plainclothes" concentrating on fugitives from the traffic regulations.

Some critics, mostly in the minority, claim the unmarked car is unsporting. This is cavilling—for there is nothing sportsmanlike about careless speeders or drunken drivers. Drastic conditions—reflected throughout the United States by the alarming upward trend in vehicle accidents, deaths and injuries—call for drastic measures.

Scofflaws: Motorists who ignore summonses for traffic violations have been appropriately tabbed "scofflaws." In a drive on these law breakers who make a mockery of the traffic court, the police department and the traffic control summons bureau have devised a system to

catch the scofflaws. A list of the most flagrant violators is compiled from the IBM machines which record every traffic summons issued. For those multiple violators who continue to flout traffic laws and regulations, warrants are issued for their arrest.

Recently the Chief of Detectives addressed sixty patrolmen who were being trained as detectives to seek out violators who failed to answer their traffic summonses during a period of amnesty. The fledgling detectives were urged to use all their "ingenuity, perserverance and intelligence" to be successful in tracking down multiple violators, and to meet attempts at bribery by swift arrests.

Night Court: With the great increase of traffic summonses, the traffic court made arrangements to provide facilities for payment of fines at night for certain offenses when the defendant pleads guilty. If a person is served with a summons for a particular violation the fine for which may be paid in night traffic court, a mimeographed notice to that effect is given the offender by the summoning officer.

Only fines for first-offense violations may be paid at night traffic court. For the following seven violations offenders MUST appear in day traffic court; speeding, play street, defective brakes, unregistered vehicle, dangerous driving, no tax stamp, failure to give right of way. In the near future, a magistrate will be assigned to sit in night traffic court to hear other than guilty pleadings.

Operation Test Tube: One of the most congested business sections in the city—or the world—was selected by the police department in late February as an experimental area to test adequate coverage by traffic policemen. This area, generally known as the "garment district," is bounded by 3rd to 9th Avenues, from 30th to 42nd Streets. One hundred probationary patrolmen were added to the complement which covers that area.

Eighty of the men were assigned to intersection duty and the remainder worked between intersections to expedite the movement of traffic and to see that parking spaces were properly used. This area contains an intensely concentrated working population during daylight hours; its streets, crowded with all manner of traffic, present every traffic obstruction to be encountered in a large city.

The experiment was designed to determine whether full cov-

erage of intersections would achieve a "perfect sequence of control" and prevent a major police headache—spill-backs.

The area has 129 street intersections, of which forty-nine of the most important are regularly covered by patrolmen. A second layer of police coverage is provided by mounted and motorcycle men. These traffic-conscious men have two primary duties: to expedite traffic and see that parking spaces are properly used.

In reviewing Operation Test Tube it is interesting to note that the evolution of semaphoric devices has been completed. From the original hand signal of traffic officers the wheel has come full circle with illuminated semaphore, electric signal by remote control, the stagger system, and now hand signals once again, supplemented by mechanical and electrical devices. After sixty days a study of the test disclosed that adequate police coverage helped to speed traffic flow but the police alone could not solve the area's traffic ills.

Co-operation With Other Organizations

In the all-out drive on traffic improvements, the fire commissioner has directed firemen responding to alarms to give summons to motorists who fail to give way during emergency runs.

During blizzards and unusual occurrences, the sanitation commissioner has co-operated with the police department in removing stranded cars from the streets.

The Navy provides instruction in safe driving for its personnel and co-operates with the police department to make its safety program effective. Accordingly, for a traffic violation involving a member of the United States Navy, a provision has been added to the police department's manual of procedure calling for a card to be forwarded to the Third Naval District, giving full particulars.

The department of marine and aviation takes cognizance of waterfront traffic jams by including plans for a new-type, square-shaped cargo and passenger pier, to provide parking spaces for approximately 1,000 automobiles on the roof. An apron twenty feet wide will extend out from the pier on all three sides facing the water. This will make it possible for trucks to drive directly on to the apron from the street. (See Figure 2.)

Many commercial, industrial and transportation concerns of the

metropolitan area have expressed eagerness to co-operate with the police department in improving traffic. Conferences with trucking and specialized industries, such as those in the garment district, are held with the commanding officers of the traffic division to iron out loading and parking problems involving long trailers and big trucks.

In co-operation with the state tax commission, the police department sends out teams to test heavy vehicles for possible violations of city ordinances. The drive is aimed specifically against the so-called "gypsy truckers." A police officer rides with the driver during this test and directs him to drive at twenty miles per hour and then apply his brakes. The decelerometer records the actual braking time and each vehicle is tested twice.

The traffic division each year sends qualified members to attend traffic courses and seminars at recognized schools. On their return, the traffic division compiles and classifies data on the latest technological advances in the traffic control field. Plausible and practical experiments, incorporating out-of-town traffic ideas, are then conducted on a small scale basis with the co-operation of the engineering bureau.

Plans for Future Traffic Control

The future of New York City traffic rests in the hands of many types of experts. The department of traffic administers traffic regulations, but the police department enforces the law. Today, in addition to these two city departments, a score of traffic-minded organizations are hard at work on the twentieth century problem of motor vehicle control.

All plans for improving traffic are predicated upon streamlining street conditions, without harming the wellbeing of the metropolis. Recently it was predicted that traffic in the metropolitan area was "on the way to a long range solution." Within five years elevated expressways across Manhattan at 30th Street and Canal Street are planned for construction to relieve crosstown congestion.

From the police standpoint, two main drives will be pursued: (1) sustained and effective enforcement of the traffic and safety laws and (2) education of the public through all possible media of communication.

Sustained enforcement means safe street conditions. Education of the public means that bottlenecks will be reduced as motorists learn to heed radio and television announcements regarding street conditions during impending hurricanes, blizzards and holiday emergencies, and to abide by the three "C's"—Care, Courtesy and Common Sense.

The best brains available are now working on plans for the real remedy of traffic problems in the years 1960, 1965, 1970 and beyond. These plans skirt the basic problem of downtown and mid-Manhattan traffic, but emphasize the development of marginal or peripheral super-arterial facilities for bypassing the congestion of the heart of New York City.

New York-New Jersey Cooperation

The Port Authority and the Triborough Bridge and Tunnel Authority in February, 1954 initiated a joint study of important links in the arterial highway system of the New York-New Jersey Metropolitan Area. In this joint study, the two governmental agencies had the assistance of outstanding consultants, public officials in both states, and many experts who pooled their knowledge and experience to meet the traffic challenge head-on.

Traffic estimates indicate that as early as 1960, 105,000,000 vehicles—an increase of 30 percent over 1954's volume of 80,300,000 —will demand crossings of the Hudson River and Upper New York Bay. Similar traffic growth has been experienced and is expected to continue on the East River Crossings, particularly on the Triborough and Bronx-Whitestone Bridges, which in 1954 handled 64,000,000 vehicles. This means proportional increases in traffic on Manhattan Island.

To meet the growing traffic, the metropolitan New York-New Jersey region has slated the greatest concentration of highway and bridge building the world has ever seen. The plans are awe-inspiring in magnitude and envision tremendous vehicular expansion for many years to come.

The future greatness of New York City depends on the ability of traffic engineers to foresee street conditions ten to fifty years in advance.

In the meantime, the police department, upon whom the lion's share of the daily traffic burden falls, will strive to maintain an alert and dynamic program for keeping vehicles and pedestrians moving in a climate of American progress and safety.

What is also needed to meet the traffic and parking problem is fresh and radical thinking to overcome the typical large-city enigmas: Safety vs. Speed; Space vs. Volume.

Traffic Engineering and Planning At a High Level in State Government

PHILIP S. MANCINI

Mr. Mancini is State Traffic Engineer and Chief of the Division of Traffic Engineering and Highway Planning in the Rhode Island Department of Public Works. He was chosen to head the new Division set up in 1954. He was director of the Rhode Island Department of Public Works from 1949 to 1954. Previously, he was public service engineer (ex-officio traffic engineer) for Providence, Rhode Island from 1942 to 1949, and served as deputy public service engineer in the same city from 1937 to 1942.

RHODE ISLAND, our most densely populated and smallest state, has traffic problems as perplexing as those of larger states. The Providence metropolitan area concentrates more than half a million people in the northeastern corner of the state at the headwaters of Narragansett Bay. The bay, effectively dividing the state, causes its principal traffic problems.

There are three other population centers of consequence: Woonsocket, Newport, and Westerly.

Rhode Island's major highway routes connect these population centers with the Providence metropolitan area. Two U. S. routes, 6 and 44, cross the state, east to west, and the Providence metropolitan area. Over these highways and urban arterial routes moves the bulk of the vehicular traffic.

Sharp Peaks of Travel

Rhode Island's annual travel totals about two and one half billion miles of which approximately two billion are in the Providence area. Critical traffic problems rise from the daily commuting flow of summer weekend and holiday travel between the metropolitan area and the beaches along Narragansett Bay and the southern ocean front. Traffic difficulties come from the sharp peaks of this travel.

The state has planned an urban freeway system of north-south

and east-west routes with a junction near the Providence central business district, with a northern expressway towards Woonsocket.

No bridge crosses Narragansett Bay from its mouth to the business district thirty-five miles to the north. Hence all east and west travel in Rhode Island, and travel to southeastern Massachusetts and Cape Cod must go north through Providence.

More than three thousand trips a day are diverted around the head of the bay to make this east-west travel. The warping of travel paths through Providence creates large traffic volumes reaching fifty thousand vehicles a day using Point Street Bridge, the southernmost crossing of the upper reaches of the bay.

Colonial Seaport Origin

Providence was a colonial seaport city. From its business center at the waterfront, Providence expanded in all directions, evolving a radial system of streets and highways. This pattern, frozen in by the development of the city, persists, with a lack of crosstown or belt routes.

The state's planned freeway system, with major route junctions near the center of the metropolitan area, effectively solves the major traffic problems in the urban area and offers a solution to the summer beach traffic problem.

The most serious problems the traffic division must solve are on the periphery of the city. Yet the remainder of Rhode Island presents a problem because of increased number of motor vehicles and the increased highway traffic since World War II. The Governor has authorized a traffic engineering division.

The old Highway Traffic Control Section, the forerunner of the present division and part of the State Maintenance Division was understaffed and short of funds. Setting up the new division recognized the scope and importance of the state traffic problem. Its function as a section in the maintenance division was upgraded to a separate division in the department of public works.

"Organize and Establish"

Part of the first year of its operation was used to organize and establish itself to provide the services required by the state. Its primary pur-

pose is to supply traffic engineering measures that will safely and expeditiously move motor vehicle traffic throughout Rhode Island.

Its contribution to highway planning is to conduct studies and investigations to provide data necessary for planning highway systems to adequately serve highway transportation needs. As a corollary activity, the division aids other cities and towns.

As a primary objective, a preliminary program was set up to study signs, pavement markings, and signals. This it was thought would contribute the most in the shortest period of time.

Traffic Sign Program

A traffic sign inventory of the 895 miles of state highways showed a total of eight thousand traffic signs. Of this total, about two thousand were regulatory signs, three thousand warning signs, and three thousand guide signs. Many were inadequate. They were substandard, and inconsistent with respect to size and installation.

Signs also had a short physical life, being of plywood with a painted message on untreated fir posts. Guide signs with multiple messages and destinations mounted on one post were practically worthless for today's traffic volumes and increased speed. Excessive signs, instead of aiding drivers, breed accidents by causing surprise and indecision in the driver's mind.

It was therefore decided that only signs of standard design would be used. All our decisions as to materials, manufacture, and installation were based on lowering maintenance costs as much as possible. All signs were to be made of aluminum, faced with reflectorized sheeting and mounted on redwood posts. Traffic *signs* are included in all new highway construction. In the modernization program, the division completed about a hundred miles of major routes.

New guide signs were limited to a maximum of three destinations on one sign. (See Figure 1). The letter size was increased to eight inches in rural areas where sufficient sign-room was available and vehicle speeds were relatively high. In urban areas where vehicle speeds are low, six-inch letters are used.

Letters are cut-out, wide-angle, flat top, of reflecting material on a black background, with an inch-and-a-half reflectorized border on large signs and a proportionately narrower border on smaller signs.

FIGURE 1. New signs at top, old signs at bottom.

FIGURE 2. Old and new route markers.

The white reflectorized message on a dark background by reason of its contrast possesses high optical and psychological values.

The public has accepted the principle of traveling by numbered routes.

Colored Route-Markers

To capitalize on standardization, colored route-markers were adopted and installed on the three U. S. routes crossing the state. Red markers with a silver shield and route number have been installed on US1; blue general direction signs similar to the marker are installed above each route-marker. Directional arrows to match the route-markers in color are installed at all prominent intersections or route turning points. (See Figure 2).

In the re-signing program, the number of guide signs is decreasing since, under the new concept of signing, the number of destinations on a guide sign is reduced to a minimum and the emphasis is placed on the route number sign. Destinations, in most cases, are signed where the driver turns off the route; hence, his directions are obtained principally from the route number.

Safety and efficient highway operation result from the minimum number of traffic signs necessary to guide the driver and warn him of hazards not self-evident. It will take approximately four years to complete the new signing program on the entire Rhode Island highway system.

Speed Zoning and Safety

A study of the state accident spot map for 1955 shows one striking fact, no pattern for the fatalities appears obvious. Accidents occurred indiscriminately throughout the state. They could not be related to highway conditions. It appears that accidents in general are more a function of the driver than of the road.

In the classic approach to accident reduction through engineering, education, and enforcement, the use of education and enforcement could be materially increased by taking advantage of such modern equipment as radar.

A study of accidents shows that at least one of the five factors—speed, inattention, following too close, improper passing, and failure to grant right-of-way—is present in practically every accident. Speed

too fast for conditions is a major underlying cause or contributing factor in most accidents. Control of excessive speed is an effective approach to accident reduction.

Rhode Island has a prima facie speed law of fifty miles an hour except in business and residential districts, and except where the highway is zoned for a different speed.[1] To control speed, it was necessary to speed-zone many state highways not previously zoned.

Speed zoning, to be respected and enforced, must be realistic as well as legal. Two radar speed meters were purchased to determine the proper speed to be posted for any section zoned. The 85 percentile determined from the graphical recorder is posted if no special hazards or high accident record exists.

Speed Limits

Speed limits set near the eighty-five percentile provide a basis for police officers to control drivers who do not conform to what the majority of drivers have determined as a reasonable and prudent speed. Where the accident rate is substantially higher than the rate for the whole route, or where roadside development with resulting traffic conflicts and unusual conditions is not readily apparent to drivers, the speed limit is set below the eighty-five percentile or near the lower pace limit. Pace is the ten-mile speed range that includes the largest number of vehicles.

[1] Motor Vehicle Code Act, Article XXV.

"Section 1. (a) No person shall drive a vehicle on a highway at a speed greater than is reasonable and prudent under the conditions and having regard to the actual and potential hazards then existing."

"(b) Where no special hazard exists that requires lower speed for compliance with paragraph (a) of this section, the speed of any vehicle not in excess of the limits specified in this section or established as hereinafter authorized shall be lawful, but any speed in excess of the limits specified in this section or established as hereinafter authorized shall be prima facie evidence that the speed is not reasonable or prudent and that it is unlawful: (1) twenty-five miles per hour in any business or residence district; (2) fifty miles per hour in other locations during the daytime."

Motor Vehicle Code Act, Article XXV.

"Section 2. Establishment of State Speed Zones.—Whenever the State traffic commission shall determine upon the basis of an engineering and traffic investigation that any prima facie speed hereinbefore set forth is greater or less than is reasonable or safe under the conditions found to exist at any intersection or other place or upon any part of a highway, said commission may determine and declare a reasonable and safe prima facie speed limit thereat which shall be effective at all times or during hours of daylight or darkness or at such other times as may be determined when appropriate signs giving notice thereof are erected at such intersection or other place or part of the highway."

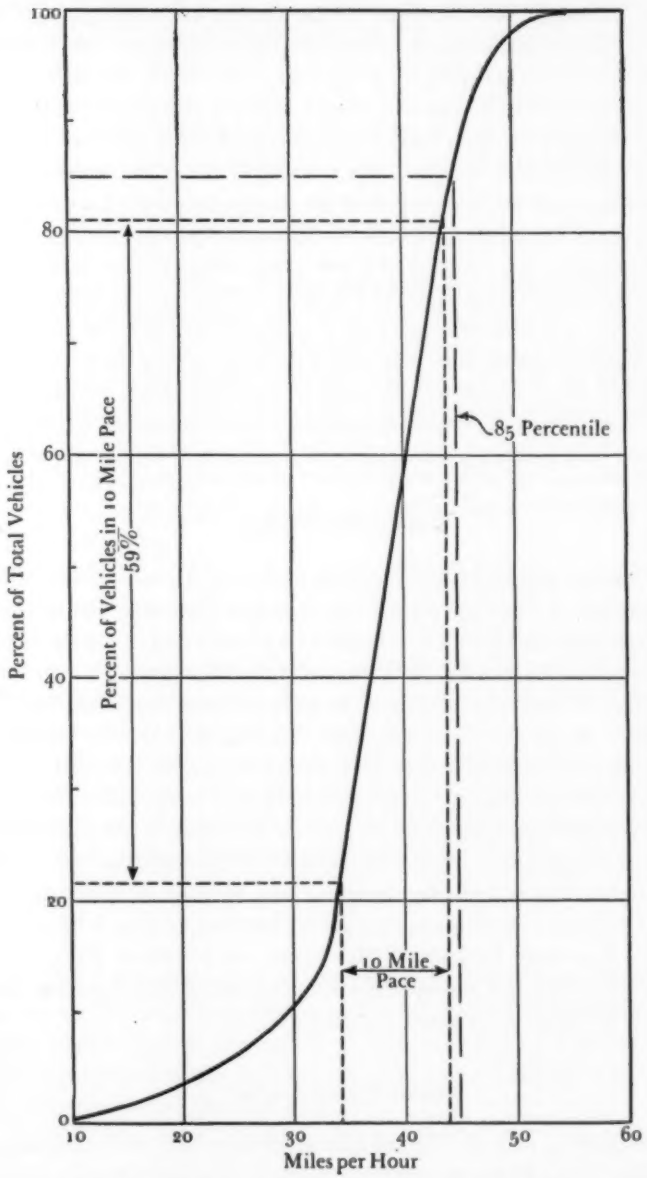


FIGURE 3. Bald Hill Road, three miles north of Tollgate Road, northbound traffic, December 13, 1955.

For example, on the speed accumulation curve (Figure 3), the eighty-five percentile speed is forty-five miles an hour, and the pace for this location is thirty-four to forty-four miles an hour. The eighty-five percentile was considered fast for this location because of hazards from roadside business establishments. Consequently, the speed limit over this section was set at thirty-five miles an hour.

Concurrence with local police on speeds zoned is obtained since enforcement is under their jurisdiction on most state roads.

It is not enough to sign a highway adequately; all distractions and extraneous advertising should be removed where possible. The sign installation was followed up with a survey of extraneous signs and with a letter notifying the responsible persons, giving the reason, and requesting their co-operation. About three hundred private signs encroaching on state highway property were removed during the first year. The majority were removed voluntarily by the owners.

Pavement Striping

There are 876 miles of state highways in Rhode Island, of which 689 are classified as two-lane roads, 187 miles as four-lane roads. They were painted with two small pavement stripers—each capable of covering about six miles a day. At this rate, it took three years to paint the 876 miles. When vehicles travel in well-defined lanes, the capacity and safety of the road are materially increased. All state highways should be striped *once* a year and the most heavily traveled, *twice*.

To do this a truck-towed striper was placed in operation in 1955. All state highways were painted and, in addition, a pavement-edge striping program was instituted to aid the motorist on rainy and foggy nights. Pavement-edge striping was applied to two hundred miles of highway during the first year. One hundred and fifty miles were on four-lane highways, fifty miles on two-lane roads. It is planned to stripe pavement-edge lines on state highways in rural areas where there is no street lighting.

Traffic Signal Lights

This division is responsible for the operation and maintenance of 132 traffic signal lights on the state highway system; 129 are vehicle

actuated. Three are fixed-time lights and comprise a progressive system on a major state arterial through a local shopping center on the outskirts of the metropolitan area. This progressive system of lights installed by the division is the first such system in the state.

To give to the traffic signal lights more visibility and prominence, their housing color was changed from dark green to yellow.

Highway Construction Projects Reviewed

The division is charged with the responsibility of reviewing all new highway construction project plans to determine the adequacy of (1) traffic signal light installations, (2) traffic signs, (3) channelization of intersections, (4) traffic capacity, intersections and ramps to serve anticipated future traffic demands, and (5) street lighting requirements.

In many cases, the review of projects goes far beyond a mere review and analysis of the project and requires a preliminary design of channelization.

Since the initiation of the expanded state highway program, the state has had three outside engineering consultants designing projects in addition to the projects underway by the state highway department. In view of the amount of funds expended by outside firms and the assurance of a proper return, a review and analysis of these projects is one of the important functions of the division.

In addition to technical aspects of analyzing a project pertaining to urban areas, its integration into the local street system and its satisfactory operation with that system require considerable discussion and negotiation with local officials.

School Crossings

This phase of traffic safety is important and sometimes delicate. We are repeatedly asked, especially by the PTA's, to install traffic signals where children cross the state highway. Our policy is to survey the facts involved to arrive at a proper solution. Installation of a traffic signal is not always the best solution.

Nevertheless, the children need protection at certain points. Because of the many ramifications—particularly parental feeling—extra

consideration is given to the problem. It is evident that the use of privately made school signs should be prohibited. The type and use should be regulated to provide official recognition.

Other points of the study were:

a. That the children should not be given a false sense of security.
b. The motorist should be effectively warned.
c. Both motorist and the children should be considered.
d. The system should be easily recognized by the motorist.

Two traffic installation standards with uniform signs were developed. One contained the regular diamond shaped yellow background sign with the word "School" on it, and a regular speed zone sign with the numeral "25" on it. The other installation contained the Stop sign with red background; beneath it a yellow background sign read "For Children." For easy manipulation, these are equipped with wheels.

Where warranted, these installations are given to the school or police authority to use as specifically directed:

1. That only adults will place the signs.
2. That they are not left in the highway when conditions are not applicable. (Warrants—35 children crossing—125 vehicles an hour.)

It is recommended that these signs be used in conjunction with a school safety patrol or other qualified personnel.

The school crossing program has proved valuable from a public relations point of view in general and, more specifically, to the many older children serving on the school safety patrol who have come to understand the value of sound traffic habits and safe pedestrian habits.

Roadside Protection

The problem of access to state highways from adjacent property and intersecting roads is one of great importance to safety and the useful life of the highway. Many miles of our major state highways are becoming hazardous and obsolete because of the uncontrolled access roadside development.

Roadside business has generated dangerous side frictions reduc-

ing traffic capacity until many roads are functionally obsolescent. This deterioration of highways is not limited to congestion and delay. It has an important bearing on the economic welfare of the metropolitan area and the state.

With this concept in mind, applications for curb cuts and highway access are now analyzed for approval. An effort is made to obtain curbed divided entrance and exit lanes skewed so that traffic can readily flow off and on the main highway.

Co-operation with the owner before the buildings are started is sought so that the advantages of properly designed entrances, exits and parking arrangements can be incorporated into the plans. To effectuate this program, planning and zoning officials, and building inspectors of all cities and towns in the state were advised to notify applicants for building permits, or for a change in zoning for property fronting on state highways, to get approval of their state highway entrances and exits before starting construction.

Experience with the highway access program strongly points out the need for a roadside control bill. Part of an answer to the problem will be the state's freeway system to provide limited-access highway facilities to serve the great volumes of traffic moving in and out of the metropolitan area daily. But these super-facilities can be justified only in special locations.

A roadside control bill introduced in the state legislature would delegate authority to a commission to establish reasonable roadside protective regulations which would:

a. Maintain the maximum efficiency of highways.
b. Reduce hazards.
c. Safeguard investments in highways by maintaining marginal areas free from encroachments.
d. Promote the orderly development of adjacent areas.

Street Lighting

The increased traffic problem is reflected in the rapidly increasing street lighting responsibility which the state is obliged to assume. Until recently there were few street lights on the state highways. Now, each year a substantial number of new modern street lighting luminaires are installed.

The urban freeway projects under construction and those being planned call for complete lighting systems. These installations are integrated with local street lighting.

Highway Planning

The traffic engineering division combined the Traffic Control Section and the Highway Planning Survey of the Division of Roads and Bridges to form a new division in the Department of Public Works. This was difficult since traffic engineering, in large part, is an operating function, while highway planning is generally a staff function concerned with long-range planning studies removed from the pressure of daily operations. Public relations are dissimilar. Traffic engineering deals directly with the public; highway planning, generally a staff function, does not.

The highway planning survey work in Rhode Island is largely confined to mapping, traffic statistics, and special traffic studies.

Public Relations

Good public relations, in their broadest sense, are absolutely necessary for a sound traffic program. The prima facie speed is determined by the eighty-five percentile method where the accident record is satisfactory. This, in effect, permits the prudent and careful driver to make his own speed limit. The driver must believe in the reasonableness and common sense of the laws if he is to respect and obey them. From the driver's point of view, anything less than this is an indication of weakness in the traffic program.

Realistic traffic laws and regulations efficiently enforced are widely recognized as an important way to reduce accidents and facilitate the flow of traffic. Recommendations made by this division are based on obtaining the full confidence and co-operation of the motorist.

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